3.0 GENERAL SITE CONDITIONS

3.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

3.1.1 Regional Geology

The flood plain of the Ohio River consists of a deep bedrock trough filled with glacial outwash deposits, overlain in places by a surficial stratum of river alluvium (Dames & Moore, *Comprehensive*). The deep bedrock trough was eroded by glacial meltwater during continental ice sheet recessions and then filled by glacial outwash sand and gravel during the Wisconsinian Glacial Stage. Beneath the glacial deposits of the flood plain, an ancient river channel can be detected where it has eroded into the bedrock floor of the trough. The bedrock trough lies at an elevation of about 500 to 580 feet msl.

The sand and gravel filling the bedrock channel are typical of Pleistocene glacio-fluvial deposits. The stratified coarse-grained deposits vary rapidly both vertically and laterally. In texture, the deposits range from fine sand to coarse gravel. In general, the coarser materials are found at greater depth, and in several places cobbles and boulders are found just above the top of bedrock. The top stratum consists of a layer of silts and clays that are less permeable than the coarse sand and gravel.

The bedrock in the region consists of nearly flat-lying sedimentary strata, mainly shales and sandstones with a few limestone and coal beds. The rocks are assigned to the Dunkard Series, which is Permian in age.

3.1.2 Regional Hydrogeology

The glacio-fluvial deposits filling the valley trough of the Ohio River form an extensive alluvial aquifer along the length of the river valley. ~~Based on the river valley pattern in this area, the unconsolidated sediment may pinch out locally, limiting the areal extent of the~~ aquifer. An example of this includes the Ravenswood Bottom area where the bedrock valley and the Ohio River converge in the north near Hills Crossing and to the south near the mouth of Mill Creek. This isolates these areas from other sections of the Ohio River alluvial aquifer. Characteristics of the aquifer may vary locally, but the deposits are generally very permeable and the elevation of the water table is similar to that of the river surface. The alluvial aquifer has a considerable saturated thickness. As a result, the aquifer also has a very high transmissivity, the ability to transmit water.

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3.2 SITE GEOLOGY AND HYDROGEOLOGY

3.2.1 Site Geology

Cross-sections through the alluvium have been constructed from boring logs to illustrate the overall configuration of unconsolidated deposits beneath the facility. The locations of the sections are shown on Plate 3. These cross-sections, presented in Plates 4 through 7, are based upon the soil-boring data collected as a result of various water supply and groundwater quality investigations conducted across the site. As illustrated in the cross-sections, the unconsolidated materials underlying the facility consist predominantly of a downward-coarsening sequence of silts and clayey silts and sand and gravel outwash deposits. These unconsolidated deposits range in thickness from approximately 80 to 100 feet and are consistent throughout the facility. They are underlain by sedimentary bedrock.

In the southern end of the site, near the Sprayfield and along the natural levee, a clayey silt is present. This unit, where present, varies from several inches to approximately 20 feet in thickness. The surficial clayey silt unit and/or fill materials are underlain by a thick sequence of glacially-derived sand and gravel outwash deposits. The uppermost 20 to 40 feet of the outwash sediments are commonly dominated by 1- to 2-foot thick bands of medium to coarse gravely sand which are interlayered with silt. Where present, the contact between the predominantly sandy unit and the overlying clayey silt is commonly gradational, making exact delineation between these two units rather subjective.

Beneath the predominantly sandy unit, at depths ranging from 40 to 65 feet below the land surface, are interlayered beds of sand and gravel. This sand and gravel unit is laterally continuous, rather poorly sorted, and usually contains only trace amounts (less than 5 percent) of silt. At many of the drilling locations, the sand and gravel deposits tend to become more coarse-grained with depth, with an overall increase in the relative abundance of gravel.

Immediately underlying the unconsolidated deposits are sedimentary rocks. Primarily of near-shore deltaic origin, this cyclothemic assemblage consists mainly of interbedded shales, siltstones, and sandstones, with some limestone and coal beds.

3.2.2 Site Hydrogeology

The uppermost aquifer unit beneath the facility is the alluvial aquifer, which is present beneath the entire site. Deposits within this aquifer consist primarily of sand and gravel outwash, which were laiddown during Pleistocene glaciation events. Groundwater within the alluvial aquifer exists under water-table conditions beneath much of the plant site; at depths ranging from about 40 to 70 feet below ground surface. The base of the alluvial aquifer system occurs at the alluvium/bedrock contact. The buried bedrock surface slopes from the valley wall toward the Ohio River, reflecting the U-shaped configuration of the bedrock valley prior to aggradation (infilling) by the glacial outwash.

The alluvial aquifer is quite prolific and is capable of sustaining million-gallon-per-day-range pumpage. Under normal river stage and non-pumping conditions, the alluvial aquifer is recharged by infiltrating precipitation and by discharges from bedrock strata buried adjacent to and beneath the alluvium.

Prior to the early 1970s, the level of the Ohio River was about 544 feet msl (Leggette, Brashears, & Graham, *Review 1976*). In the early 1970s, the level of the river was raised about 16 feet resulting in a normal pool elevation of 560 feet msl. The rise in river level resulted in a similar rise in aquifer water level. Because of this rise in water level in the unconsolidated material, the aquifer thickness is now about 40 to 50 feet. This rise in water level has increased the aquifer's capability for transmitting water. The transmissivity of the aquifer was increased from about 150,000 gallons per day per ft (gpd/ft) prior to the early 1970s to more than 215,000 gpd/ft.

3.2.2.1 Groundwater Flow Directions

Water levels for many of the observation wells, monitoring wells and piezometers were collected on January 18, 1996. The water levels presented in Table 3-1 were used to construct the potentiometric surface map included on Plate 8. The natural direction of the groundwater flow under non-pumping conditions is from the valley wall towards the Ohio River. RAC is currently operating a number of pumping wells, referred to as blocking wells, that pump water from the alluvial aquifer. This pumping system alters the natural direction of the groundwater flow. The blocking wells (R-1, R-2, R-3, R-4, F-1, and F-10) are shown on Plate 3. These wells are located within central areas of the plant proper, and are pumped at a combined average rate of about 1,200 to 1,300 gallons per minute (gpm), or about 1.7 to 1.8 million gallons per day (mgd).

Except for routine maintenance, the blocking wells are in operation 24 hours per day, 365 days per year. Table 3-3 lists the individual pumping rate ranges for the blocking wells. The pumps are checked daily to ensure that they are operating. The Blocking Well system is discussed in Section 23.1.

RAC also operates two wells on the south end of the facility, F-8 and F-9, on an intermittent basis to supply the plant with both production and potable water. The average flow from these wells is about 0.75 mgd.

Groundwater in the northern and central areas of the facility flows toward the blocking wells, while groundwater in the southern section of the site flows toward the production wells. Operation of the Sprayfield and seasonal ponding of the surface runoff from adjacent areas of the site has produced groundwater mounding in the clayey silt unit beneath the Sprayfield. Except for this area of mounded groundwater, groundwater flow across the site is from the Ohio River toward the pumping wells.

3.2.2.2 Groundwater Flow Velocity

The hydraulic properties of the lower portion of the sand and gravel aquifer have been determined through an evaluation of existing pumping test records from RAC fabrication well F-7, which is situated adjacent to Pond 1 and screened across the lower portion of the alluvial aquifer (Geraghty & Miller, *Part B*). Data from a pumping test conducted in 1968 have been analyzed using Jacob's equation for a non-leaky artesian unconfined aquifer, with corrections to reflect water-table conditions. The pumping test drawdown data indicated that the transmissivity (T) of the lower portions of the aquifer in the area of F-7 is about 400,000 gpd/ft. Based upon an estimated aquifer saturated thickness of 40 feet, this T corresponds to a hydraulic conductivity (K) of 0.472 cm/sec. Based on January 1996, groundwater levels, the average hydraulic gradient across the site is approximately 0.001 ft/ft. Using these hydraulic conductivity values and hydraulic gradient values, the groundwater flow velocity at the facility can be roughly approximated using the following equation:

$$V = KI/n \times 1.03 \times 10^6$$

where,
V = velocity, ft/yr
K = average hydraulic conductivity, cm/sec
I = average hydraulic gradient, ft/ft
n = assumed effective porosity (assumed to be 0.25 for predominantly sand and gravel deposits)
1.03×10^6 = conversion factor from cm/sec to ft/yr

Groundwater flow velocity at the site, based on January 1996 average hydraulic gradients and the results of the F-7 pumping test, is approximately 1,900 ft/yr.

3.3 SITE GEOMORPHOLOGY AND TOPOGRAPHY

As noted above, the site is bounded to the east by bedrock hills, and the bottomland is characterized by alluvial deposits. The alluvial sediments are present as terraces deposited during various stages of the pre-historic Ohio River as the glacial melt waters receded. The lowest areas of the bottomland have probably been reworked by the more recent river stage and are characterized by siltier sediments deposited near ground surface. A natural levee is present along the length of the site. Ground elevations range from 560 feet to 640 feet msl in the terrace/bottomland areas to over 800 feet in the adjacent bedrock hills.

3.4 SITE SOILS

Soils at the Ravenswood facility are of the Ashton, Wheeling, Lakin Association, characterized as deep, mainly well drained, nearly level, brownish soils on Ohio River bottom lands and terraces [SCS, 1961]. Soils in the areas of potliner management and in the Oil Recovery Pond area are Wheeling fine sandy loam and Wheeling gravely sandy loam. They have developed on terraces from glacial outwash material carried by the Ohio River. The silt loam upper soil profiles are underlain by sand and gravel. The soils are described as "draughty," meaning that they have a low residual moisture content. Soils in the area of the Industrial Landfill and the Sprayfield are Huntington silt loam and Landside fine silt loam. The Huntington series is described as deep, well drained soils on first bottoms. These soils have developed in recent alluvium derived from a mixture of limestone, limy shale, and some acid sandstone and shale. The Landside series is described as deep, moderately well drained to somewhat poorly drained soils of first bottoms. These soils have developed in acid to neutral alluvium derived from residual soils that vary widely. C/03

Surficial soils across parts of the developed area of the facility also include reworked and fill material. Soils underlying the surficial deposits at the facility are described in the samples/core logs in Appendix B and are discussed in Section 3.2.

3.5 AREA SURFACE WATERS

The predominant surface water feature in the area, as shown in the USGS topographical map included in Appendix A-1, is the Ohio River which meanders around the north, west, and south sides of the RAC property. The 100-year floodplain of the Ohio River (elevation 588.2 msl) is shown on Plate 2. The floodplain encompasses the Sprayfield and Industrial Landfill areas and the Potliner Loadout Area. The Industrial Landfill is built up such that it is mostly above the 20-year floodplain (elevation 582 msl). Spring Creek flows from the northeast to southeast to the south of the facility and enters the Ohio River approximately 1 mile south of the Fabrication Plant. Wildcat Creek is a wet-weather stream located to the northeast of the facility that transmits stormwater runoff and discharge from the hills to the east of the facility to the Ohio River to the north. Other surface waters at the site include man-made drainage and impoundments such as Outfalls 001 through 004 and the ponds associated with the Oil Recovery System. These ponds are isolated from the groundwater and natural surface water system by means of a synthetic liner. Kera Lakes, also identified on the topographic map, are man-made impoundments east of the facility in the bedrock hills.

Several locations within the RAC property boundary were identified as temporarily to permanently flooded by the US Department of Interior National Wetlands Inventory. These areas were identified using high altitude aerial photographs and were not ground-proofed. A copy of the National Wetlands Inventory map that includes the RAC property is provided in Appendix A. In the developed area of the facility (as defined in Figure 2-1), the following units were inappropriately identified in the inventory: 002 Interceptor Basin, 004 Interceptor Basin, Oil Recovery Ponds, and Emergency Spill Basin. These areas were obviously designated as temporarily to permanently flooded because they were shown by aerial photography as containing water. This, of course, is the designed purpose of these units.

3.6 SITE WELL INVENTORY AND CONSTRUCTION DETAILS

The available construction and pump data on facility wells are provided in Table 3-2. There is a wide range of construction materials and methods among the site wells due to a variety of uses for production wells, observation wells, monitoring wells, and piezometers. Casing and screen construction materials include black steel, galvanized steel, and polyvinyl chloride (PVC). The production and blocking wells are equipped with turbine pumps. Some of the monitoring wells are equipped with helical rotor submersible pumps. Dedicated bailers are present in some of the K-200-series wells in the Sprayfield. Construction logs for many of the wells are presented in Appendix B. Wells for which no construction or boring logs are available are listed on a table in Appendix B.

3.7 GENERAL CLIMATIC CONDITIONS

The area around the RAC facility has a warm temperate climate. Precipitation is well distributed throughout the year. Rainfall is highest in June and July and lowest in October and November. Intense summer thundershowers of short duration occur. The 25-year 30-minute rainfall intensity is 1.7 inches, while the 25-year 24-hour rainfall intensity is 4.5 inches. Annual snowfall is approximately 20 inches. Usually the snow remains on the ground for only short periods. Alternate freezing and thawing in winter is very common. Average winter temperatures are above freezing, but short cold spells occur. [*SCS*, 1961 and *Climatic Atlas of the US*, 1968].

Figure 3-1 is a wind rose for Huntington, West Virginia, which is the location nearest Ravenswood with available wind data. Huntington is approximately 55 miles southwest of Ravenswood. The Huntington wind rose indicates that the predominant wind direction is from the south (9.0 percent of observations). Winds are from the south through the west 37.6 percent of the time. Wind speeds are calm (0 to 3 miles per hour) about 25.2 percent of the time, while winds exceed 16 mph about 2.3 percent of the time.

3.8 GENERAL CONSTITUENT FATE AND TRANSPORT

A constituent released to the environment may remain at the point of release or it may be transported by air, groundwater, or surface water. Upon release, the constituent may remain unaltered for a significant time period or it may degrade to daughter products. Potential migration refers to routes a constituent may take from a source area. This report specifically addresses hazardous constituents that may have been managed at solid waste management units identified at the RAC facility. This section discusses general fate and transport processes that may occur at the facility.

Potential routes of migration are illustrated in Figure 3-2. Constituent migration routes are influenced by physical and chemical properties of the constituent; the type, quantity, or location of the constituent source material; site characteristics such as topography, geology, and hydrology; chemical conditions of the media; and local climatic conditions.

3.8.1 Migration in Air

A constituent can enter the atmosphere by volatilization and by generation of fugitive dust. The propensity of a constituent to volatilize depends on the properties of the matrix in which it occurs and the properties of the constituent itself. A constituent with a high vapor pressure has a tendency to volatilize. A dense matrix or one with a high organic matter content is likely to exhibit minimal volatilization of a constituent. Volatile constituents that are present in water and are highly soluble in water are also less likely to volatilize.

Potentially volatile constituents which have been managed in SWMUs at the site include emulsified coolant constituents such as lighter weight hydrocarbons, toluene, and xylene. Higher molecular weight hydrocarbons, PAHs, and PCBs have low volatility and migrate to the air at a very low rate. Because these constituents are associated with oily waste, they are typically not associated with the generation of fugitive dust, which is suppressed by oil.

Constituents managed at the facility that may be adsorbed to fugitive dust include cyanides from spent potliner. The extent to which a constituent may migrate as fugitive dust depends on the particle sizes of the material and the speed and direction of the wind. Higher wind speeds increase both the quantity and the dispersion of fugitive dust. Smaller or lighter dust particles will disperse farther from the source area.

3.8.2 Migration in Surface Water

A constituent may migrate to local surface waters via stormwater runoff or groundwater discharge into surface waters. The propensity of a constituent to migrate via surface water depends on the properties of the constituent, the properties of the source materials, and the physical setting of the potential source. Soluble constituents and constituents adsorbed to small, easily eroded particulates are most likely to migrate with and to surface water. However, the physical setting of the potential source dictates whether migration is feasible. Source materials that are managed indoors or in contained systems have little opportunity to migrate via the surface water pathway.

Current solid waste management at the facility is conducted in a manner that minimizes the opportunity for surface water migration. Prior to 1979, management of spent potliner, which is described in detail in Section 4, was conducted out-of-doors in a manner that would allow for migration. Cyanide in spent potliner is water soluble, and can leach from the carbon matrix of the source material into adjacent soil and surface water. Additionally, dust from spent potliner management can be carried by the overland flow of water. Oily wastes from the emulsified coolant oil recovery system are managed in a closed system that minimizes the opportunity for surface migration of constituents. Waste coolant is managed in tanks with secondary containment and in surface impoundments with dike systems. The water phase of the waste coolant is land applied in the Sprayfield where it infiltrates the surface soil. The Sprayfield area has been graded to minimize the potential for surface water runoff. A low dike is located along the eastern perimeter of the Sprayfield to enhance containment. The Sprayfield is located in a low-lying area that is flooded approximately once every 2 to 5 years. During periods of potential flooding, Ravenswood monitors the river stage and discontinues land application of wastewater during periods of inundation. Wastewater is stored in the remainder of the system, until the Sprayfield area is no longer flooded.

3.8.3 Migration in Soil and Groundwater

A constituent can migrate into and through the soil by leaching from the source material or by the source material physically moving into the soil. Soluble constituents, such as cyanide from spent potliner, may leach into and through the soil. Additionally, very fine particles of spent potliner may migrate into and mix with the soil. The movement of particles through soil is limited by relative sizes of the particles and the interstices through which they must move. Once a soluble constituent reaches the groundwater table, it migrates with groundwater flow. Because groundwater is a poorly mixed system, density gradients may affect the location of the plume vertically within the groundwater.

In the area of oily wastewater management, the source material itself, the oil or the emulsification, may migrate through the soil. Normally immobile constituents, such as PCBs and PAHs, can migrate more readily than otherwise expected when they are accompanied by a more mobile co-solvent such as oil.

Movement through the subsurface of a nonaqueous phase liquid, such as the oil phase from the Oil Recovery System, is controlled by several processes. The following discussion is summarized from *Light Nonaqueous Phase Liquids*, US EPA, July 1995. Upon release, the oil will migrate downward under the force of gravity. As it migrates downward, a fraction of the oil is retained by capillary forces as residual in the soil pores, thereby depleting the amount of oil migrating downward. Migration will continue until the mass is tied up as residual or until contiguous free-phase liquid encounters a physical barrier, such as a lower permeability strata or the water table. Once the capillary fringe of the water table is reached, the oil moves laterally as a continuous free-phase layer along the upper boundary of the water-saturated zone due to gravity and capillary forces. Although principal migration is expected to be in the direction of decreasing water table elevation, some migration may occur in other directions.

Infiltrating precipitation and passing groundwater in contact with residual or mobile oil may dissolve soluble components and form an aqueous phase contaminant plume. However, the water solubility of a constituent in multicomponent nonaqueous phase liquids is estimated as its water solubility as a pure solute times its mole fraction in the mixture. Thus, for a complex mixture such as the oil in the Oil Recovery System, most constituents, which already have relatively low solubilities, are significantly less soluble because they represent small mole fractions of the mixture.

In summary, oil that migrates to the subsurface may be present in the following conditions: residual oil in the unsaturated zone, residual oil in the saturated zone, dissolved constituents in the saturated zone, and contiguous nonaqueous phase liquid at the capillary fringe of the water table. It is only the contiguous liquid at the water table and constituents that dissolve into the ground water that are potentially mobile. The amount of oil immobilized as residual may increase over time due to fluctuations of the water table that "smear" the previously mobile oil into areas where the nonaqueous phase liquid is no longer contiguous.

3.8.4 Observed Migration of Constituents

Specific hazardous constituents associated with materials and waste management at the facility are discussed in Sections 4 through 22. Section 23 discusses the results of various groundwater investigations that have been conducted at the site. In general, cyanide appears to have migrated over land and through the soil to the groundwater from certain areas of former potliner management. Migration of cyanide within the groundwater appears to be controlled by the Blocking Well System described in Section 23.

Oil associated with former operations of bentonite-lined ponds that were part of the Oil Recovery System has migrated to the water table in an area immediately east of the Oil Recovery Ponds. The area that has water table monitoring wells containing floating oil has been relatively stable since the oil was first discovered in 1985. As discussed in Section 9, an interim measure is currently being enacted to attempt recovery of the mobile portion of the oil. The interim measure will not affect residual oil in the saturated and unsaturated zones.

The Industrial Landfill groundwater monitoring system has detected elevated concentrations of chlorides. The only consistent hazardous constituent detection is low concentrations of 1,1-dichloroethane in monitoring well LF-7. The Sprayfield was designed to allow limited migration of oily wastewater from the Oil Recovery System to facilitate treatment. Biological activity within the Sprayfield area subsequently reduces constituents to background levels at the boundary of the waste treatment area.

There is no evidence of off-site migration of hazardous constituents from facility activities other than via permitted releases (wastewater permits).

TABLE 3-1
WATER LEVEL ELEVATIONS - JANUARY 1996
Ravenswood Aluminum Corporation

WELL NO.	TOP OF CASING ELEVATIONS (feet)	WATER LEVEL (feet below TOC)	WATER ELEVATIONS (feet)
DM-1	626.99	69.16	557.83
DM-2	627.32	69.57	557.75
DM-3	607.14	48.65	558.49
DM-4	606.25	47.82	558.43
DM-5	624.37	67.06	557.31
DM-7	618.82	60.85	557.97
DM-8	599.62	41.09	558.53
DM-9	627.88	69.45	558.43
DM-10	630.69	72.59	558.10
GM-1	626.17	67.59	558.58
GM-2	627.17	68.69	558.48
GM-3	626.78	68.17	558.61
GM-4	626.65	67.83	558.82
GM-5	621.62	N/A	N/A
GM-6	623.55	64.63	558.92
GM-7s	621.76	N/A	N/A
GM-7d	621.35	62.55	558.80
GM-8	601.30	42.31	558.99
WP-1	622.63	N/A	N/A
WP-2	621.55	N/A	N/A
WP-3	611.03	N/A	N/A
WP-4	608.26	49.19	559.07
IT-1s	626.16	N/A	N/A
IT-1i	626.04	67.36	558.68
IT-1d	626.20	67.54	558.66
IT-2	624.79	N/A	N/A
IT-3	624.72	66.00	558.72
RW-1	619.84	N/A	N/A
W-1	604.40	46.09	558.31
W-2	594.76	37.08	557.68
W-3	604.68	47.00	557.68
FT-1	582.63	23.21	559.42
T-4	617.49	58.77	558.72
T-5	582.31	23.79	558.52
T-6	586.51	27.73	558.78
T-8	618.92	59.57	559.35

TABLE 3-1
WATER LEVEL ELEVATIONS - JANUARY 1996
Ravenswood Aluminum Corporation

WELL NO.	TOP OF CASING ELEVATIONS (feet)	WATER LEVEL (feet below TOC)	WATER ELEVATIONS (feet)
T-9	617.02	60.31	556.71
RT-5	585.22	26.52	558.70
Ohio River	586.60	24.94	561.66
MW-1	589.48	29.58	559.90
MW-2	569.21	8.61	560.60
MW-3	569.75	10.19	559.56
MW-4	638.39	77.98	560.41
MW-5	612.53	53.74	558.79
MW-6	631.01	71.46	559.55
MW-7	626.60	67.03	559.57
MW-8d	567.62	7.96	559.66
MW-8s	568.02	4.61	563.41
LF-1	567.82	5.21	562.61
LF-2	569.53	10.26	559.27
LF-3	570.65	8.14	562.51
LF-4	631.23	71.09	560.14
LF-5	638.41	77.97	560.44
LF-6	567.32	3.01	564.31
LF-7	566.92	2.08	564.84
K-101	574.26	12.85	561.41
K-102	572.29	9.41	562.88
K-103	574.57	10.40	564.17
K-104s	569.37	2.08	567.29
K-104d	569.50	8.01	561.49
K-105	580.38	DRY	--
K-106	573.75	12.44	561.31
K-107	566.52	1.73	564.79
K-108	570.80	6.41	564.39
K-201	570.60	2.93	567.67
K-202	569.85	2.58	567.27
K-203	571.26	5.95	565.31
K-204	573.45	11.64	561.81
K-205	575.51	14.09	561.42
K-206	576.31	15.19	561.12
K-207	574.49	13.43	561.06
K-208	571.28	7.47	563.81
K-209	570.12	2.02	568.10

TABLE 3-1
WATER LEVEL ELEVATIONS - JANUARY 1996
Ravenswood Aluminum Corporation

WELL NO.	TOP OF CASING ELEVATIONS (feet)	WATER LEVEL (feet below TOC)	WATER ELEVATIONS (feet)
TW-1	593.98	34.98	559.00
A	572.27	10.16	562.11
B	572.13	10.85	561.28
C	573.57	11.73	561.84
D	569.03	8.23	560.80
E	569.84	8.57	561.27
F	575.91	14.84	561.07
G	572.59	11.11	561.48
F-8-OW	598.58	40.18	558.40
F-9-OW	595.94	38.17	557.77
PZ-1	576.69	16.75	559.94
F-6	633.84	75.26	558.58
R-5TW	584.35	25.78	558.57
RT-2.5	575.01	15.15	559.86
RT-3.5*	587.99	28.62	559.37
RT-3.75*	588.48	27.79	560.69

N/A - Well contains floating oil.
* - Surveyed elevations may not be accurate. Well casings have been damaged

TABLE 3-2
LAND SURFACE AND SCREENED INTERVAL ELEVATIONS FOR WELLS AND PIEZOMETERS
Ravenswood Aluminum Corporation
Ravenswood, West Virginia

WELL ID	TOTAL DEPTH BELOW GROUND SURFACE *(Notes a b), (feet)*	REFERENCE POINT *(RP)*	WELL ELEVATION AT RP *feet, msl*	STICK UP *(feet)*	LAND SURFACE ELEVATION *feet, msl*	SCREENED INTERVAL DEPTH BELOW GROUND SURFACE *(feet)*	SCREENED INTERVAL ELEVATIONS *feet, msl*
Sprayfield/Landfill Monitoring Wells							
MW-1 (DM-11)	54.0	*Top 4" PVC*	589.48	1.77	587.71	39.0 - 49.0	538.71 - 548.71
MW-2	37.0	*Top 1.25" PVC*	569.21	0.25	568.96	27.0 - 37.0	531.96 - 541.96
MW-3	39.5	*Top 1.25" PVC*	569.75	2.81	566.94	29.5 - 39.5	527.44 - 537.44
MW-4	99.0	*Top 1.25" PVC*	638.39	2.95	635.44	89.0 - 99.0	536.44 - 546.44
LF-1	35.5	*Top 1.25" PVC*	567.82	1.07	566.75	30.5 - 35.5	531.25 - 536.25
LF-2	34.5	*Top 4" PVC*	569.53	1.01	568.52	29.5 - 34.5	534.02 - 539.02
LF-3	15.73	*Top of PVC*	570.65	2.30	568.35	5.73 - 15.73	552.62 - 562.62
LF-4	79.65	*Top of PVC*	631.23	-0.25	631.48	64.65 - 79.65	551.83 - 566.83
LF-5	84.0	*Top of PVC*	638.41	2.30	636.11	69.0 - 84.0	552.11 - 567.11
LF-6	14.0	*Top of PVC*	567.32	2.30	565.02	4.0 - 14.0	551.02 - 561.02
LF-7	14.0	*Top of PVC*	566.92	2.30	564.62	4.0 - 14.0	550.62 - 560.62
K-201	13.3	*Top of PVC*	570.60	2.44	568.16	3.3 - 13.3	554.86 - 564.86
K-202	12.5	*Top of PVC*	569.85	1.85	568.00	2.5 - 12.5	555.50 - 565.50
K-203	18.0	*Top of PVC*	571.26	1.64	569.62	8.0 - 18.0	551.62 - 561.62
K-204	19.0	*Top of PVC*	573.45	1.92	571.53	9.0 - 19.0	552.53 - 562.53
K-205	20.0	*Top of PVC*	575.51	2.0	573.51	10.0 - 20.0	553.51 - 563.51
K-206	21.5	*Top of PVC*	576.31	2.0	574.31	11.5 - 21.5	552.81 - 562.81
K-207	19.1	*Top of PVC*	574.49	1.80	572.69	9.1 - 19.1	553.59 - 563.59
K-208	16.0	*Top of PVC*	571.28	1.58	569.70	6.0 - 16.0	553.70 - 563.70
K-209	14.45	*Top of PVC*	570.12	1.85	568.27	4.45 - 14.45	553.82 - 563.82
Sprayfield/Landfill Piezometers:							
K-101	19.0	*Top of PVC*	574.26	0.90	573.36	9.0 - 19.0	554.36 - 564.36
K-102	17.0	*Top of PVC*	572.29	1.76	570.53	7.0 - 17.0	553.53 - 563.53
K-103	17.0	*Top of PVC*	574.57	3.80	570.77	7.0 - 17.0	553.77 - 563.77
K-104s	12.0	*Top of PVC*	569.37	1.66	567.71	4.5 - 12.0	555.71 - 563.21
K-104d	34.0	*Top of PVC*	569.50	1.70	567.80	29.0 - 34.0	533.80 - 538.80
K-105	17.0	*Top of PVC*	580.38	5.00	575.38		
K-106	18.0	*Top of PVC*	573.75	1.65	572.10	8.0 - 18.0	554.10 - 564.10
K-107	15.0	*Top of PVC*	566.52	1.54	564.98	5.0 - 15.0	549.98 - 559.98
K-108	15.0	*Top of PVC*	570.80	2.30	568.50	5.0 - 15.0	553.50 - 563.50

TABLE 3-2
LAND SURFACE AND SCREENED INTERVAL ELEVATIONS FOR WELLS AND PIEZOMETERS
Ravenswood Aluminum Corporation
Ravenswood, West Virginia

WELL ID	TOTAL DEPTH BELOW GROUND SURFACE *(Notes a b), (feet)*	REFERENCE POINT *(RP)*	WELL ELEVATION AT RP *feet, msl*	STICK UP *(feet)*	LAND SURFACE ELEVATION *feet, msl*	SCREENED INTERVAL DEPTH BELOW GROUND SURFACE *(feet)*	SCREENED INTERVAL ELEVATIONS *feet, msl*
TW-1	68.92 a	*Alum. Collar*	593.98	2.27	591.71	*unknown*	522.79*
TW-2	40.45 a	*Top of PVC*	570.63	2.05	568.58	*unknown*	528.13*
A	33.53 a	*Top of Steel*	572.27	1.20	571.07	*unknown*	537.54*
B	33.94 a	*Top of Steel*	572.13	1.30	570.83	*unknown*	536.89*
C	26.78 a	*Top of Steel*	573.57	3.40	570.17	*unknown*	543.39*
D	31.25 a	*Top of Steel*	569.03	1.60	567.43	*unknown*	536.18*
E	42.80 a	*Top of Steel*	569.84	0.00	569.84	*unknown*	527.04
F	51.43 a	*Top of Steel*	575.91	1.50	574.41	*unknown*	522.98*
G	47.09 a	*Top of Steel*	572.59	1.30	571.29	*unknown*	524.20*
F-8-OW	79.50 a	*Top of Steel*	598.58	1.40	597.18	*unknown*	517.68*
F-9-OW	72.10 a	*Top of Steel*	595.94	2.20	593.74	*unknown*	521.64*
Potliner Management Area Monitoring Wells:							
DM-1	91.0	*Alum. Collar*	626.99	1.43	625.56	77.0 - 87.0	538.56 - 548.56
DM-2	110.0	*Alum. Collar*	627.32	1.21	626.11	97.0 - 107.0	519.11 - 529.11
DM-3	91.0	*Alum. Collar*	607.14	1.88	605.26	77.0 - 87.0	518.26 - 528.26
DM-4	72.0	*Alum. Collar*	606.25	1.58	604.67	58.0 - 68.0	536.67 - 546.67
DM-5	91.0	*Alum. Collar*	624.37	1.53	622.84	76.0 - 86.0	536.84 - 546.84
DM-7	84.0	*Alum. Collar*	618.82	1.61	617.21	69.0 - 79.0	538.21 - 548.21
DM-8	62.0	*Alum. Collar*	599.62	1.16	598.46	47.0 - 57.0	541.46 - 551.46
DM-9	93.0	*Alum. Collar*	627.88	1.90	625.98	78.0 - 88.0	537.98 - 547.98
DM-10	94.0	*Alum. Collar*	630.69	1.64	629.05	81.0 - 91.0	538.05 - 548.05
Potliner Vault Wells:							
W-1 (DM-6)	71.0	*Top of PVC*	604.40	1.46	602.94	56.0 - 66.0	536.94 - 546.94
W-2	59.0	*Top of PVC*	594.76	1.04	593.72	44.0-54.0	539.72 - 549.72
W-3	69.0	*Top of PVC*	604.68	1.71	602.97	54.0-64.0	538.97 - 548.97
Oil Recovery Pond Wells:							
GM-1	80.35	*Top of PVC*	626.17	2.32	623.85	60.35 - 80.35	543.50 - 563.50
GM-2	81.71	*Top of PVC*	627.17	2.96	624.21	61.71 - 81.71	542.50 - 562.50
GM-3	79.60	*Top of PVC*	626.78	2.06	624.72	59.60 - 79.60	545.12 - 565.12
GM-4	79.05	*Top of PVC*	626.65	2.45	624.20	59.05 - 79.05	545.15 - 565.15
GM-5	72.86	*Top of PVC*	621.62	2.76	618.86	53.18 - 72.86	546.00 - 565.68
GM-6	77.10	*Top of PVC*	623.55	1.82	621.73	57.10 - 77.10	544.63 - 564.63

TABLE 3-2
LAND SURFACE AND SCREENED INTERVAL ELEVATIONS FOR WELLS AND PIEZOMETERS

Ravenswood Aluminum Corporation
Ravenswood, West Virginia

WELL ID	TOTAL DEPTH BELOW GROUND SURFACE *(Notes a b), (feet)*	REFERENCE POINT *(RP)*	WELL ELEVATION AT RP *feet, msl*	STICK UP *(feet)*	LAND SURFACE ELEVATION *feet, msl*	SCREENED INTERVAL DEPTH BELOW GROUND SURFACE *(feet)*	SCREENED INTERVAL ELEVATIONS *feet, msl*
GM-7s	74.55	*Top of PVC*	621.76	1.87	619.89	54.55 - 74.55	545.34 - 565.34
GM-7d	78.60	*Top of PVC*	621.35	1.70	619.65	68.60 - 78.60	541.05 - 551.05
GM-8	53.50	*Top of PVC*	601.30	2.16	599.14	33.50 - 53.50	545.64 - 565.64
IT-1s	67.7	*Top of PVC*	626.16	2.27	623.89	57.5 - 67.7	556.19 - 566.39
IT-1i	87.7	*Top of PVC*	626.04	2.10	623.94	77.5 - 87.7	536.24 - 546.44
IT-1d	104.4	*Top of PVC*	626.20	2.32	623.88	94.2 - 104.4	519.48 - 529.68
IT-2	*unknown*	*Top of PVC*	624.79	2.42	622.37	*unknown*	
IT-3	72.89 a	*Top of PVC*	624.72	2.06	622.66	*unknown*	549.77*
WP-1	72.0	*Top of PVC*	622.63	2.40	620.23	62.0 - 72.0	548.23 - 558.23
WP-2	73.0	*Top of PVC*	621.55	2.20	619.35	58.0 - 73.0	546.35 - 561.35
WP-3	59.5	*Top of PVC*	611.03	2.22	608.81	44.5 - 59.5	549.31 - 564.31
WP-4	60.0	*Top of PVC*	608.26	2.92	605.34	45.0 - 60.0	545.34 - 560.34
RW-1	85.0	*Top of Steel*	619.84	0.42	619.42	53.0 - 85.0	534.42 - 566.42
Other Wells and Piezometers:							
FT-1	63.2 b	*Alum. Collar*	582.63	1.96	580.67	*unknown*	517.47*
RT-2.5	41.45 a	*Alum. Collar*	575.01	2.52	572.49	*unknown*	531.04*
RT-3.5	75.37 a	*Alum. Collar*	587.99	2.52	585.47	*unknown*	510.10*
RT-3.75	72.42 a	*Alum. Collar*	588.48	2.52	585.96	*unknown*	513.54*
RT-5	66.7 b	*Alum. Collar*		2.72		~58 - 64	
R-5 tw	70.4 a	*Alum. Collar*	584.35	2.02	582.33	*unknown*	511.93*
T-4	96.35 a	*Alum. Collar*	617.49	2.96	614.53	*bottom 3ft.*	518.18 - 521.18
T-5	73.7 a	*Alum. Collar*		1.51		*bottom 3ft.*	
T-6	65.03 a	*Alum. Collar*		1.36		*bottom 3ft.*	
T-8	111.53 a	*Alum. Collar*	618.92	3.02	615.90	*bottom 3ft.*	504.37 - 507.37
T-9	100.55 a	*Top of PVC*	617.02	-0.20	617.22	*bottom 3ft.*	516.67 - 519.67
F-6	98.40 a	*Top of Steel*	633.84	0.80	633.04	*unknown*	534.64*

TABLE 3-2
LAND SURFACE AND SCREENED INTERVAL ELEVATIONS FOR WELLS AND PIEZOMETERS
Ravenswood Aluminum Corporation
Ravenswood, West Virginia

WELL ID	TOTAL DEPTH BELOW GROUND SURFACE *(Notes a b), (feet)*	REFERENCE POINT *(RP)*	WELL ELEVATION AT RP *feet, msl*	STICK UP *(feet)*	LAND SURFACE ELEVATION *feet, msl*	SCREENED INTERVAL DEPTH BELOW GROUND SURFACE *(feet)*	SCREENED INTERVAL ELEVATIONS *feet, msl*
Monitoring Wells and Piezometers Installed During RFI:							
MW-5	59.0	*Top of PVC*	612.53	2.7	609.8	*49.03 - 58.51*	551.3 - 560.8
MW-6	74.7	*Top of PVC*	631.01	2.4	628.6	*64.73 - 74.21*	*554.4 - 563.9*
MW-7	72.0	*Top of PVC*	626.60	2.3	624.3	*62.15 - 71.65*	552.7 - 562.2
MW-8s	22.0	*Top of PVC*	568.02	2.3	565.7	*12.25 - 21.75*	544.0 - 553.5
MW-8d	48.0	*Top of PVC*	567.62	2.6	565.0	*38.25 - 47.75*	517.3 - 526.8
PZ-1	24.5	*Top of PVC*	576.69		573.7	*14.65 - 24.15*	549.6 - 559.1

* Well bottom elevation
a = Field measurement performed in 1994 or 1995.
b = Value from Appendix A of Dames & Moore November 1982 Report. Reference point for measurement unspecified.

TABLE 3-3
BLOCKING WELL PUMPING RATE RANGES
Ravenswoods Aluminum Corporation

BLOCKING WELL DESIGNATION	APPROXIMATE PUMPING RATE RANGE
R-1	250 to 300 gallons per minute
R-2	110 to 150 gallons per minute
R-3	230 to 360 gallons per minute
R-4	1980s - 245 to 290 gpm 1990s - 510 to 545 gpm
F-1	135 to 145 gallons per minute
F-3/F-10	150 to 160 gallons per minute

Pumping rate ranges obtained from pumping rates recorded between 1986 to 1996.

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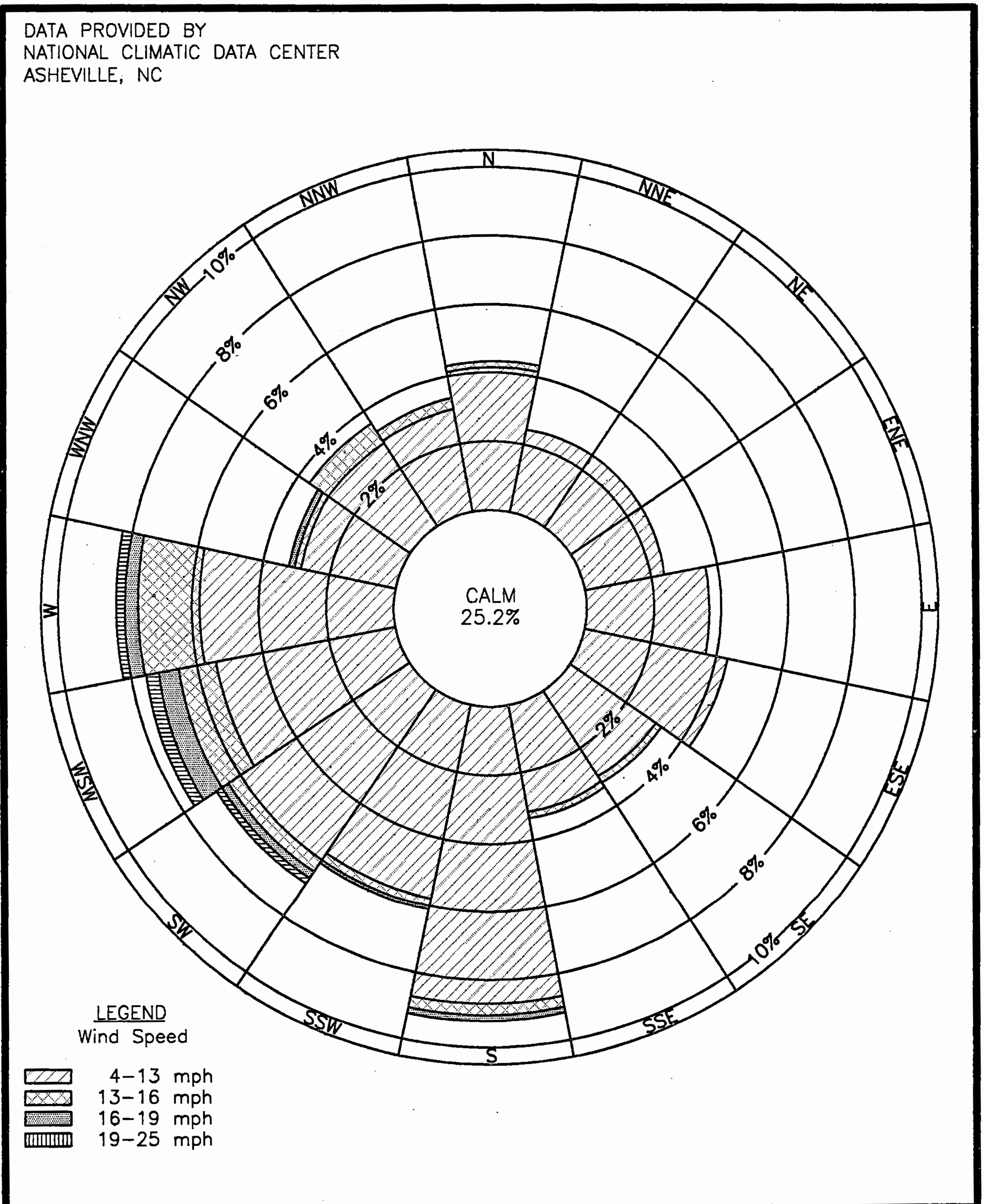
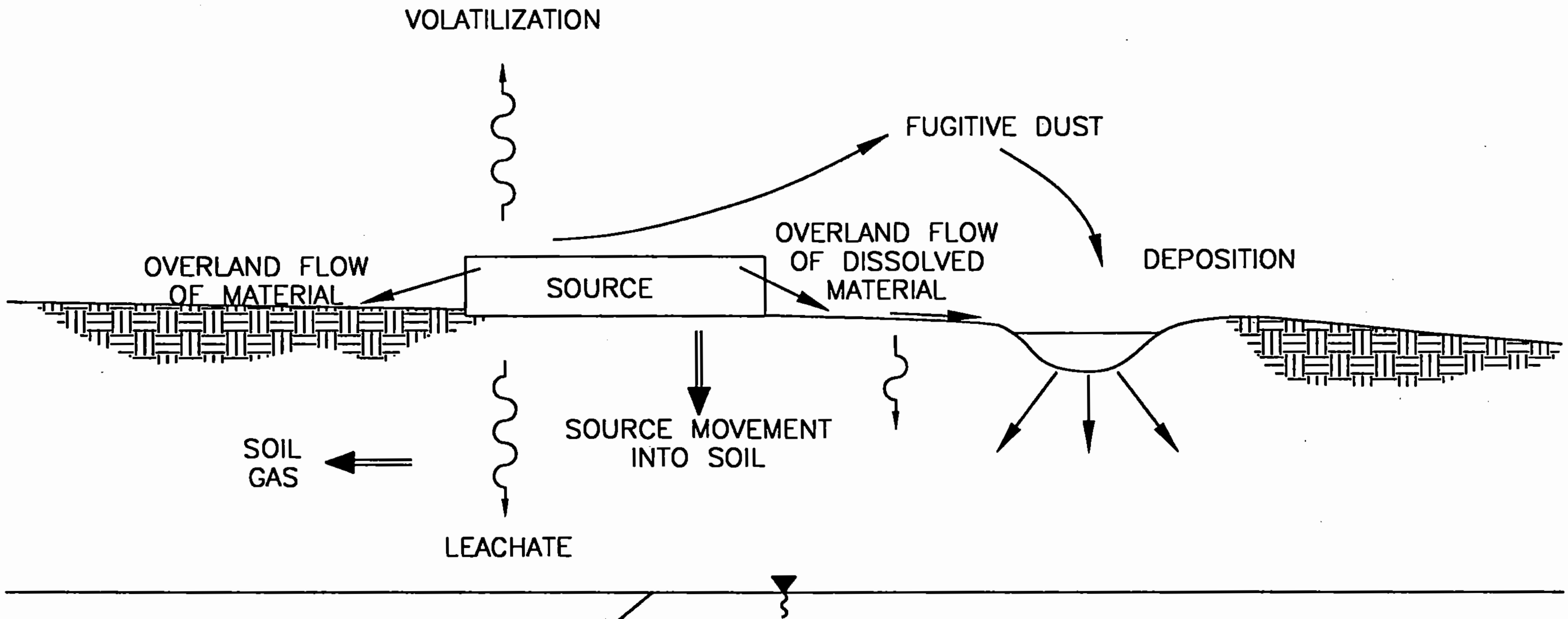


FIGURE 3–1
WIND ROSE

RMT INC. 70410.21

RAVENSWOOD ALUMINUM CORPORATION



70410.21
0296

FIGURE 3-2
POTENTIAL MIGRATION PATHWAYS

RAVENSWOOD ALUMINUM
RAVENSWOOD, WV

4.0 AREAS OF FORMER POTLINER MANAGEMENT

Production of aluminum at the facility involves dissociation of the metal from the oxygen in aluminum oxide (alumina ore). This reduction process takes place in an electrolyte reduction cell called a pot. At the elevated temperatures that occur during aluminum reduction, cyanide compounds are generated when carbon from the cathode reacts with nitrogen from the atmosphere and possibly other sources (Dames & Moore, *Comprehensive*). When an electrolytic cell (pot) fails, these cyanide compounds are contained in the spent potliner materials which must be removed from the pot before it is rebuilt. Cyanide compounds can be leached out of the spent potliner that is in contact with water. These cyanide compounds can undergo complexing chemical reactions as they pass through the unsaturated soil layer and the groundwater aquifer. Fluoride, another material associated with potliner, can also be leached out of potliner by contact with water.

Prior to 1979, some spent potliner management and accumulation occurred outside at the facility. This resulted in leaching of cyanide from some of these areas through the soils and into the groundwater. In 1969, the presence of cyanide in some of the plant's wells was discovered (KACC, *ORSANCO*). At that time an effort was undertaken to control the migration of cyanide in the environment. In 1976, four wells were dedicated for use as blocking wells to maintain a groundwater flow gradient away from the Ohio River in the Areas of Former Potliner Management. Over the years, two more wells were added to this system, resulting in a total of six wells for groundwater gradient control and cyanide removal. These wells, R-1, R-2, R-3, R-4, F-1, and F-10 (replaced F-3 in 1990), are referred to as the blocking wells. Groundwater extracted from the blocking wells is discharged to the Ohio River through Outfall 004 at concentrations that are safe to human health and the environment and in accordance with NPDES Permit limits.

The common forms of cyanide in groundwater include free cyanide, simple cyanide, and complexed cyanide. Total cyanide is a measure of all of the forms of cyanide. According to the ORSANCO report, the cyanide in the groundwater at the facility is predominantly iron-complexed cyanide, which, compared to free cyanide, is relatively non-toxic (see Section 4.1.1).

This section presents information relative to the toxicity of free and complexed cyanides, the Areas of Former Potliner Management at the facility, and the results of soil analyses in the Areas of Former Potliner Management. The discussion of cyanide concentrations in the groundwater is presented in Section 23.1 of this report. This section also presents an evaluation of further investigation needs regarding the Areas of Former Potliner Management.

4.1 ISSUES RELATIVE TO CYANIDE

4.1.1 Toxicity of Cyanide

Cyanide is present in the soils and groundwater in certain of the Areas of Former Potliner Management. Common forms of cyanide in groundwater are as follows (PEI Associates, *Characterization*):

- Free cyanide as the cyanide anion (CN^-) and hydrogen cyanide (HCN),
- Simple cyanide [i.e., CuCN, KCN, $Hg(CN)_2$, etc.], and
- Complexed cyanides [i.e., $Fe(CN)_6{}^{4-}$, $Cu(CN)_3{}^{2-}$, etc.], which also include ferrocyanide and ferricyanide precipitates [e.g., $Fe_2Fe(CN)_6$].

The concentrations of free cyanide relative to complexed cyanides depends on the pH of the groundwater and the values of the stability constants of the complexing metals present. A decrease in the pH drives the dissociation reaction of metal complexes forward by removing the cyanide ion (CN^-). However, iron, gold, and cobalt cyanide complexes have high stability constants, indicating that these complexes do not dissociate easily to free cyanide, even at very low pH values.

Free cyanide is toxic to man and animals at certain concentrations, and possible exposure routes include: inhalation, ingestion, or skin adsorption (PEI Associates, *Characterization*). The toxicity of various metal-cyanide complexes is attributable almost solely to the concentration of free cyanide in equilibrium with the complexed salt. Ferrocyanide is approximately 200 to 300 times less toxic to rats than is free cyanide, and for fish the toxicity of complexed cyanides is approximately 10,000 times lower than for free cyanide (PEI Associates, *Characterization*; Hartung, *Differential*). In fact, most investigators consider iron-complexed cyanide to be non-toxic.

Although iron cyanide complexes can be transformed to free cyanides by photolytic reactions, these reactions occur in an arena of competing physical and chemical processes which determine the ultimate fate of the individual cyanide compounds. Therefore, only a small proportion of any released iron cyanide complexes ever appear in the form of free cyanides in ambient surface waters (Hartung, *Differential).* Consequently, the potential effects of iron cyanide complexes and other strongly complexed cyanides on human health and on aquatic ecosystems appear to be significantly less severe than those posed by the simple cyanides.

Studies performed on the groundwater at the facility have indicated that the form of cyanide in the groundwater is primarily complexed cyanide (Geraghty & Miller, *1993 Annual*). In the late 1970's, samples of water and residue from various wells and concrete cathode storage areas were taken and sent to KACC's Center for Technology in Pleasonton, California, for qualitative and quantitative analyses (KACC, *ORSANCO*). The X-ray and infrared analyses indicated that the main cyanic compound in the groundwater samples collected was ferrocyanide [Fe(CN)6]-4. Also, relative concentrations of metals in the groundwater in the Areas of Former Potliner Management indicate that it would be expected that the majority of the complexed cyanide in the groundwater would be in the form of iron complexes. Therefore, it is believed that the complexed portion of the cyanide is primarily iron complexed cyanide.

4.1.2 Analytical Methods for Complexed Cyanide

The various methods available to analyze for cyanide in water are as follows:

- Total Cyanide Analyses,
- Weak Acid Dissociable Cyanide Analyses,
- Cyanides Amenable to Chlorination Analyses, and
- Microdiffusion Analyses.

Even though the toxicological basis for the Water Quality Criteria, Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) were based on free cyanides (ASTM D-2036; Method A), US EPA selected analytical techniques for total cyanide or cyanide amenable to chlorination because they have no approved free cyanide analytical techniques.

As the name indicates, total cyanide measures all cyanide species in a water stream, including the relatively non-toxic complexed cyanides. Cyanides amenable to chlorination (ASTM D-2036; Method B {cyanides amenable to chlorination by difference} and Method D {cyanides amenable to chlorination without distillation; the short-cut method}) and US EPA method 9010, which combines an analysis of cyanides amenable to chlorination with cyanides hydrolyzable by strong acids, are empirical methods which are subject to interferences and problems related to accuracy and precision because they are difference methods that aggregate the errors inherent in the procedures contributing to the overall method. An inter-laboratory comparison study found the variability for the analyses for total cyanides to be acceptable, but found the variability associated with cyanide amenable to chlorination to be excessive (Hartung, *Differential*).

The alternate analytical weak acid dissociable cyanides method (ASTM D-2036; Method C) has explicitly been designed to exclude the iron-complexed cyanide from the analyses in an effort to measure only the more toxic compounds of cyanide. However, the measurement of weak acid dissociable cyanides can be subject to interferences, as in several instances weak acid dissociable cyanide concentrations exceeded the total cyanide concentrations in split samples (Hartung, *Differential*).

The microdiffusion method (ASTM D-4282) seeks to assess the cyanide fraction that can be mobilized as HCN. This method typically results in reported cyanide concentrations less than either the weak acid dissociable or cyanides amenable to chlorination methods and is believed to generate more representative actual reported cyanide concentrations than these other methods.

4.1.3 Discharge and Groundwater Limits

The US Public Health Service Drinking Water Standards of 1962 established an acceptable standard for drinking water of 0.2 mg of cyanide (CN^-)/L (Hartung, *Differential*). This was a consensus standard based upon professional experience rather than upon a formal risk assessment methodology. A daily maximum cyanide level of 0.2 mg/L was incorporated in the NPDES Permit discharge limits for the facility. US EPA adopted these concentrations in 1980 as criteria for ambient water quality, even though the criteria document presented evidence for an allowable daily intake of 8.4 mg/day, which would be equivalent to a water concentration level of 4.2 mg/L.

In order to present a case for raising the cyanide discharge limits in the 1979 NPDES Permit, KACC prepared the ORSANCO Variance Request for Cyanide. This variance request included toxicological studies performed by Rolf Hartung at the University of Michigan with water from the facility.

In most cases, free cyanides have been found to be rapidly fatal to fish at concentrations above 0.20 mg/L, but during these studies most fish survived total cyanide concentrations of 73 times that level for 4 days. These studies confirmed previous analytical results indicating that the cyanide in the groundwater at the facility must be primarily in the form of stable complexes, and that these complexes must be much less toxic to fish than free cyanides. The report also included a river mixing study, which indicated that dispersion of discharged groundwater resulted in concentrations of total cyanide of below detection limits in less than 25 feet from the discharge pipe even with discharges of 10 mg/L of total cyanide.

The current NPDES limit for cyanide discharge is a monthly average of 2.5 mg/L total cyanide and a daily maximum of 5.0 mg/L total cyanide in Outfall 004. Cyanide discharge concentrations in Outfall 004 have been decreasing over the years and have been below the discharge limit for the last 10 years. Figure 4-1 is a graph of total cyanide versus time at the 004 Outfall.

4.2 AREAS OF FORMER POTLINER MANAGEMENT

Spent potliner has been managed at the facility in the locations indicated on Plate 2 and as described below:

- Old Northwest Pot Dump

  During the early years of the plant operation, from approximately 1959 to 1963, KACC accumulated potliner separated from failed pots in a borrow pit, referred to as the Old Northwest Pot Dump. This area was located west of the Reduction Plant (Versar (US EPA Contractor), *RCRA*). The spent potliner accumulated at this location was from monolithic pots and would be expected to contain approximately 1 to 2 percent total cyanide. When the Potliner Loadout Area was installed on the riverbank in 1963, the potliner that had been accumulated at the Old Northwest Pot Dump was transported to the Potliner Loadout Area and shipped to Reynolds Aluminum Corporation for cryolite recovery. By the end of 1963, KACC had removed all potliner from the Old Northwest Pot Dump Area, leaving an empty borrow pit. KACC backfilled this borrow pit to grade in 1980 as part of a study performed by Dames & Moore to evaluate the groundwater and soil in the vicinity of the Areas of Former Potliner Management. The former location of the Old Northwest Pot Dump is relatively flat and is currently covered with vegetation.

- Pot Soaking Piers

  From 1963, when the Pot Soaking Piers were constructed, to 1970, KACC separated potliner following soaking with water on the Pot Soaking Piers. The spent potliner came from monolithic type of pots at this time. The Pot Soaking Piers consisted of large concrete blocks (approximately 5 feet tall and 25 feet long, spaced 10 feet apart) situated on a concrete pad. The concrete blocks allowed four pots to be elevated off the concrete pad at one time. Spray hoses were elevated above the pots and used to fill the pots with water. This water caused the hot potliner to expand and liners to break apart. The process of physically removing the potliner and associated materials was performed on a concrete pad adjacent to the piers. Drainage from the Pot Soaking Piers flowed through a sewer to Outfall 003. Storm water runoff from this area drained overland to the southwest through the Drainage Path, indicated on Plate 2. KACC dismantled the piers in the late 1970s. The former location of the Pot Soaking Piers is partially covered by the southern portion of the Potliner Pile. There are no visible remnants of the former Pot Soaking Piers.

- <u>Potliner Loadout Area</u>

  From 1963 to 1970, KACC accumulated potliner and loaded it onto barges from a loading area, referred to as the Potliner Loadout Area. This area is located south of the present ore unloading dock. The potliner was shipped to Reynolds Aluminum Corporation for cryolite recovery. During 1963, potliner was moved from the Old Northwest Pot Dump to a building in this area for barge shipment. After 1963, failed pots were soaked on the piers, broken out in the vicinity of the piers, and transported to the Potliner Loadout Area for accumulation prior to shipment. The Potliner Loadout Building had a concrete foundation that measured approximately 120 feet by 100 feet. The structure had concrete walls on two sides that were situated perpendicular to the river. On top of each wall were steel girders, which elevated the roof approximately 5 feet above the top of the concrete walls. The potliner was unloaded into one end of the Potliner Loadout Building and pushed out the other end onto a barge by an endloader. In 1970, the Ohio River water level was raised approximately 16 feet, and the Potliner Loadout Area Structures were removed. The only parts of the Potliner Loadout Area structures still standing are two parallel walls that likely extended from the former building along a ramp to the river.

- <u>Pot Soaking Pits and Elephant Shed</u>

  In 1970, the Pot Soaking Pits and the Elephant Shed were constructed, resulting in an integrated system for potliner breakout and accumulation at a single location. From 1970 to 1979, KACC carried out pot soaking in reinforced concrete pits located southwest of the present Potliner Pile and adjacent to the Elephant Shed. Pots were delivered to the Pot Soaking Pit area, lifted by a crane into the Pot Soaking Pits, soaked, lifted out of the Pot Soaking Pits by the crane, and broken out by repeatedly dropping the pots on a concrete pad with imbedded railroad rails located outside the Elephant Shed. There were four six-foot deep Pot Soaking Pits that could each contain one totally submerged pot. The water in each of the pits was heated to prevent freezing in the winter. The Elephant Shed was a concrete structure constructed with the same dimensions as the Potliner Loadout Building. The roof from the Potliner Loadout Building was moved to the Elephant Shed in 1970. From 1970 to 1972, the potliner and other materials broken out from the pots were placed in the Elephant Shed until transfer to barges for transportation to Reynolds Aluminum Corporation. In 1972, the market for spent potliner disappeared and no more shipments of potliner were made to Reynolds Aluminum Corporation. From 1972 to 1979, the broken out potliner and associated material was accumulated in the Elephant Shed, and, about once a week, these materials were placed in the Potliner Pile. The Potliner Soaking Pits were cleaned out, filled in, and covered with asphalt in about 1980. The Elephant Shed was in use for accumulation of potliner until 1979, when the Potliner Breakout and Accumulation Buildings were built. Currently, the Elephant Shed is used to store construction debris, flue bricks, and dirt. No other operations or storage occurs in the Elephant Shed. Surface runoff is towards the west along the Elephant Shed and to the Drainage Path to the north.

- Potliner Pile

In 1972, accumulation of spent potliner began on a concrete slab. The construction and filling of this slab with spent potliner was followed by the construction of second and third adjacent slabs in 1974 and 1976 (Dames & Moore, *Comprehensive*). These first three units were open piles that were placed on concrete pads. Currently, all three slabs have potliner on them. The slabs have 18-inch side walls, and a sump for slabs 1 and 2 was connected to the Pot Soaking Pits. The pipe connecting the sump to the Pot Soaking Pits was reportedly removed when the Pot Soaking Pits were backfilled in 1980. The sump is believed to still be in place. The sump is located beneath the Potliner Pile cover. A pipe believed to be extending vertically from the sump enables the sump to be monitored for accumulating water. None has been observed. The placement of potliner on the slabs ceased before a cover was placed over the pile in the summer of 1979. The cover was constructed of asphalt on the top surface and gunite on the sides. During February, 1980, spent potliner from the Potliner Breakout and Accumulation Buildings was relocated to this area into a subsidiary pile that was constructed on a pad of bentonite and soil, south of the existing slabs. A mixture of bentonite and soil was used to cover this portion of the pile. An impermeable synthetic membrane was installed over the whole area between May 11 and July 23, 1982, as part of the study and cleanup associated with the 1982 Comprehensive Hydrogeologic Investigation by Dames & Moore. This entire covered area, including all of the adjacent sequential accumulations just described, is what comprises the Potliner Pile. No potliner has been added to the pile since 1980. The potliner pile continues to be owned and maintained by KACC.

? What Are They observing ? ?

- Potliner Breakout and Accumulation Buildings (Buildings 65 and 66)

In 1979, the Potliner Breakout and Accumulation Buildings were constructed to facilitate potliner removal and management in an enclosed environment (Versar, *RCRA*). In 1979, KACC began accumulation of spent potliner in piles on the floor of Building 66. In one year, Building 66 was filled, and a permit was obtained to allow placement of the spent potliner material on the subsidiary pile of the Potliner Pile. About this time, advancements in aluminum manufacturing and computerized control of the processes resulted in an increase in the life of the pots. Therefore, after the potliner was removed from Building 66 in 1980, Building 66 did not fill up again until about 1986. At this time, the potliner was removed and placed in the RCRA-type permitted Potliner Vault. Prior to the sale of the facility to RAC in 1989, KACC moved all potliner located in Building 66 to the Potliner Vault, and the vault was closed as a landfill. KACC continues to own and maintain the Potliner Vault. Currently, potliner is still broken out in Building 65, and potliner is accumulated for less than 90 days in Building 66 in covered steel tubs prior to truck transport to a hazardous waste facility.

Section 3.8.2 discusses the surface water migration pathway. Areas potentially affected by stormwater runoff or drainage from the above units include the following:

- Storm water runoff from the Potliner Pile and Elephant Shed and the former locations of the Pot Soaking Piers and Pot Soaking Pile followed a small path, referred to as the Drainage Path, westward towards the river (Dames & Moore, *Comprehensive*). This Drainage Path has been filled and the area regraded to a relatively flat, grassy surface. Using pre-grading topographic maps of this area and what surface indications remain, the location of the former Drainage Path can be ascertained for most of its length. The Drainage Path is approximately 1,800 feet long and was previously (1976-1979) ponded up at its mid-length by a small dam for stormwater retention (see Plate 2 for location of impoundment). This basin has since been regraded and no longer exists.
- Outfall 003 is an NPDES-permitted outfall to the Ohio River. Water from the Pot Soaking Piers flowed into the sewer to Outfall 003. Part of the runoff from the Potliner Pile and the Elephant Shed and the Former Locations of the Pot Soaking Pits and the Pot Soaking Piers was discharged through Outfall 003. Currently, Outfall 003 discharges stormwater runoff from the Storm water drainage area which contains the Potliner Pile and the Elephant Shed. Storm water runoff, which passes beneath the plant fence at the location of the former Drainage Path, enters a drop-box surface drain into the culvert to Outfall 003.
- Runoff from the Old Northwest Pot Dump followed a path, referred to as the Northwest Pot Dump Drainage Path, westward approximately 800 feet before accumulating in a low area near the riverbank (Dames & Moore, *Comprehensive*). This low area near the river bank has been termed the Bottomlands. It was recently noticed that standing water in the Bottomlands drains to the Ohio River through a concrete pipe at the northwest end of the Bottomlands.

Section 3.8.1 discusses the air migration pathway in general. Migration as dust may have occurred at the Old Northwest Pot Dump, the Potliner Loadout Area, the Elephant Shed, the Potliner Pile, and the Potliner Breakout and Accumulation Buildings. Potential migration of constituents to the environment, including dust migration in air, has been addressed by moving spent potliner management indoors and by closing outdoor spent potliner management units as detailed later in this section. In the Potliner Accumulation Building (Building 66), dust shrouds have been installed to reduce dust migration from the loading area. A dust collection system will be installed on the exhaust fans in Building 65 in 1996. Surface soil samples were collected in the vicinity of the areas of former potliner management during the RFI to assess residual cyanide concentrations.

In addition, KACC placed spent potliner material in the Potliner Vault, which is shown on Plate 2. This vault was constructed in the late 1980s, in accordance with RCRA standards. Current potliner management is limited to the Potliner Breakout and Accumulation Buildings, the Potliner Pile, and the Potliner Vault. The Potliner Pile and the Potliner Vault are still owned and maintained by KACC. RAC has managed spent potliner in an enclosed environment since it has operated the facility.

4.3 ANODE BURNOFF PILE

The Anode Burnoff Pile, noted in the 1982 Dames & Moore hydrogeologic investigation report, was removed prior to 1980. Currently, anode burnoffs are accumulated on a concrete pad southwest of the Reduction Plant. Under non-ideal conditions during the reduction of alumina ore to molten metal, anodes in contact with the molten cryolite bath can overheat and burn off the copper rods from which they are hung into the bath. These carbon anodes are termed burnoff. Anode burnoffs are crushed and can be recycled back into anode production, but only at a controlled rate. During rare occasions of non-ideal conditions such as the startup of a large number of new pots, the rate of burnoff generation may exceed the ability to recycle them into anode production. When Dames & Moore performed their investigation in the early 1980s, a pile of these anode burnoffs existed at the location shown on Plate 2.

The 1982 Dames & Moore Report identified the Anode Burnoff Pile as an area where the status with regard to leachable cyanide needed to be investigated. However, subsequent leaching tests performed as part of the Dames & Moore 1980 through 1982 hydrogeologic investigation indicated that the amount of total cyanide that leached from anode burnoff when soaked in distilled water was approximately 0.008 mg/kg, compared to the 2,700 mg/kg from potliner material. Therefore, it was determined that the anode burnoffs did not contain appreciable quantities of leachable cyanide, and the anode burnoff pile was not a significant source of cyanide at the site.

The Anode Burnoff Pile observed by Dames & Moore in 1982 was subsequently removed. Currently, anode burnoffs are accumulated on a concrete pad southwest of the Reduction Plant during any period of excessive generation. This rarely occurs because of improving reduction technologies.

4.4 INVESTIGATIONS OF SURROUNDING SOILS

4.4.1 1980-1981 Hydrogeological Investigation

In 1980 and 1981, Dames & Moore performed a hydrogeological investigation at the facility, which primarily focused on the issues of cyanide in the soils and groundwater in the Areas of Former Potliner Management. The reported soil sample results from that investigation and sampling around the anode burnoff pile are presented below; the reported groundwater sample results are presented in Section 23.1 of this DCC Report.

The investigation included the drilling of 39 soil borings at various locations; however, it is not clear whether the samples were collected at hot spots such as areas lacking vegetation or areas of colored soil. Cyanide analyses in samples collected from these borings were performed as follows: a sub-sample of the soil was dried, pulverized, and thoroughly mixed; 1 gram of the mixed material was placed in 20 milliliters of distilled water and was agitated vigorously. After settling, the decant was analyzed for total cyanide. Because this modified cyanide analysis was used, Dames & Moore acknowledged in their report that the actual cyanide concentrations in the soil would most likely be higher than those reported for this investigation. A summary of the cyanide analytical results of the soil sampling data is provided in Table 4-1. The sampling locations are shown in Figure 4-2, Figure 4-3, and Figure 4-4. The detailed results of these analyses are contained in Appendix C-1 (Dames & Moore, *Comprehensive*).

Dames & Moore's hydrogeologic investigation concluded with several recommendations for the Areas of Former Potliner Management. The recommendations which pertained to the Areas of Former Potliner Management other than the Potliner Pile, which is still owned and maintained by KACC and is to be addressed under a separated Consent Order, and the corresponding actions taken to date are detailed below (see Appendix C-2 for complete list of responses to recommendations).

Dames & Moore recommended that minor improvements be made to the Potliner Breakout and Accumulation Buildings, including repairs to the building siding, improvements in fugitive dust control, and measures to prevent spilling of potliner materials. The repairs to the siding were performed in 1984. During that same time period, KACC established practices to minimize fugitive dust emissions and prevent spillage.

Dames & Moore recommended that all transfers of spent potliner material be completed under dry conditions and that all pots awaiting separation be protected from the weather. KACC performed these operations from 1983 to 1989, when RACC sold the property. RAC has performed these operations as recommended since 1989.

Dames & Moore recommended that any potliner material remaining from historical operations in the Potliner Loadout Area be removed, and KACC undertook two separate removal actions in this area in the early 1980s.

Dames & Moore recommended that future accumulation facilities be designed and operated to prevent contact between potliner material and water from any source. The expansion of the Potliner Accumulation Building in 1984 and the construction of the Potliner Vault have incorporated this recommendation.

Dames & Moore recommended that research be carried out to determine which of the technologically feasible remedial alternatives is more appropriate for soils in the Bottomlands. In 1983, KACC stated that they had reviewed the groundwater monitoring data from DM-8, and that the data indicated a recovery trend with total cyanide concentrations approaching the drinking water standards. Figure 4-5 shows cyanide concentrations in monitoring well DM-8. KACC also stated that vegetation in the Bottomlands area had been recovering steadily. Therefore, KACC concluded that the area should continue to be monitored until a time that no improvements were evident. At that time, KACC would undertake research into technically feasible remedial alternatives.

Dames & Moore recommended that steps be taken to control erosion in the former drainage path from locations of the Potliner Pile and Elephant Shed and the former locations of the Pot Soaking Piers and Pot Soaking Pits. KACC completed regrading efforts in this area in the mid 1980s.

Dames & Moore recommended that the geometry of the blocking wells system be changed to direct the groundwater containing cyanide into two distinct plumes. In 1983, KACC agreed that this change would be beneficial; however, it was KACC's belief that this change would only be appropriate after issues such as the Ohio River mixing studies had been completed and NPDES Permit and other issues relevant to total cyanide discharges had been resolved. KACC reiterated this position in 1987.

Dames & Moore further recommended that modifications be made to permit flow rate monitoring and chemical sampling at individual blocking wells. Individual blocking well monitoring and sampling were initiated in 1984.

Dames & Moore recommended that a data management plan be developed and that groundwater monitoring be continued in the Areas of Former Potliner Management as detailed in the "Technical Guidance Manual for Groundwater Sampling," issued by Dames & Moore in November 1982. These recommendations have been followed sine 1984.

Dames & Moore recommended that one or two additional monitoring wells be installed south of the Industrial Landfill to monitor the effects of pumping the new water production wells F-8 and F-9. This recommendation was addressed by KACC as part of the Industrial Landfill Permit renewal.

4.4.2 1986 Interim RFA Report

The 1986 NUS (US EPA Contractor) Interim RFA discussed the Potliner Pile and the Potliner Breakout and Accumulation Buildings. NUS, did not mention any of the other Areas of Former Potliner Management. NUS proposed continued groundwater monitoring around the Potliner Pile in addition to possibly placing the pile's contents in a RCRA-approved landfill. No recommendations were presented for the Potliner Breakout and Accumulation Buildings.

4.4.3 1988 Versar RFA Report

During the 1987 Versar RFA Sampling Visit, two soil samples were collected in the area surrounding the Potliner Breakout and Accumulation Buildings (Versar, *RCRA*). No cyanide concentrations above the detection limit were reported in either of these samples. In the Draft RFA, Versar concluded that no further regulatory action was necessary at the Potliner Breakout and Accumulation Buildings. No soil samples were collected at any other Areas of Former Potliner Management.

4.5 PAST AND CURRENT GROUNDWATER MONITORING

4.5.1 Blocking Well and Production Well Monitoring

Groundwater samples from blocking wells R-1, R-2, R-3, and F-3 have been analyzed for total cyanide between four and twelve times per year from 1969 to the present (F-3 was replaced by adjacent well F-10 in 1990). Groundwater samples from wells F-2 and F-4 were analyzed for total cyanide between four and twelve times per year from 1971 to 1983. Groundwater samples from wells R-7 F-5, and F-7 were analyzed for total cyanide between four and twelve times per year from the late 1970s to 1983. Groundwater samples from R-4 to have been analyzed for total cyanide between four to twelve times per year from 1977 to the present, and samples from F-1 have been analyzed for total cyanide between four and twelve times per year from 1971 to the present. Additionally, since 1984, groundwater from blocking wells R-1, R-2, R-3, R-4, F-1, and F-3 (F-10 after 1990) have been analyzed for free cyanide and total fluoride 12 times per year.

Currently, the six blocking wells are being analyzed 12 times per year for total cyanide, free cyanide, and total fluoride. This sampling is being performed in accordance with the NPDES Permit requirements for Outfall 004. The groundwater from these blocking wells is also being analyzed for general groundwater quality parameters in accordance with the NPDES Permit. The results of this groundwater monitoring are presented in Section 23.1 of this DCC Report.

4.5.2 Dames & Moore Well Monitoring

Groundwater samples from the 11 DM-Series wells have been analyzed for total cyanide and other general groundwater quality parameters between four and ten times per year since 1981. Groundwater samples from well RT-5 have been analyzed for total cyanide and other general groundwater quality parameters since 1984. RAC currently analyzes groundwater samples from the 11 DM-series wells and well RT-5 for total cyanide and other general groundwater quality parameters between four and six times per year. These groundwater monitoring results are presented in Section 23.1 of the DCC Report.

4.6 ASSESSMENT OF FURTHER INVESTIGATION NEEDS

Based on the results of the Dames & Moore investigation and visual inspection of the facility, it is recommended that soil samples be collected at select locations in the Areas of Former Potliner Management. It is recommended that soil borings be drilled in the areas in or around the Old Northwest Pot Dump, Northwest Dump Drainage Path, Bottomlands, Potliner Pile, Potliner Breakout and Accumulation Buildings, Pot Soaking Piers, Pot Soaking Pits and Elephant Shed, and the Drainage Path. It is recommended that soil and sediment samples be collected in the area of Outfall 003 and the Potliner Loadout Area. Based on the materials stored at the anode burnoff pile, it is probably not a source of cyanide, but it is recommended that soil samples be collected in this area for confirmation purposes. The proposed soil sampling is described in detail in the Data Collection Quality Assurance Plan of the RFI Workplan. The evaluation of the further groundwater sampling required is presented in Section 23.1 of this DCC Report.

4.7 SUMMARY OF AREAS OF FORMER POTLINER MANAGEMENT

Production of aluminum involves the dissociation of the aluminum and oxygen atoms in aluminum oxide (alumina ore) in an electrolytic reduction cell called a pot. Cyanide compounds are generated in the carbon cathode material in the potliner. Cyanide compounds are contained in the spent potliner, which must be removed from the electrolytic reduction cell before it is rebuilt. Cyanide compounds can be leached out of the spent potliner which is in contact with water. These compounds can undergo complexing chemical reactions as they pass through the unsaturated soil layer and the groundwater aquifer. Past management of spent potliner outside at the facility has resulted in soil and groundwater containing cyanide in some areas of the facility. To prevent migration of the cyanide in the environment, groundwater pumping from the blocking wells has been performed. Groundwater pumping will continue to be performed.

The common forms of cyanide in groundwater are free cyanide, simple cyanide, and complexed cyanides. Free cyanide is toxic to man and animals at certain concentrations. However, most investigators consider iron complexed cyanide to be non-toxic. Studies performed on the groundwater containing cyanide at the facility have indicated that the groundwater consists primarily of iron complexed cyanide. Even though the toxicological basis for regulations was limited to free cyanides, US EPA selected analytical methods for total cyanide or cyanide amenable to chlorination. In his research, Hartung (*Differential*) concluded that, of the three analytical methods for cyanide analyses (weak acid dissociable, amenable to chlorination, and microdiffusion), only the microdiffusion technique represents a repeatable and accurate method for determining free cyanide concentrations.

The current cyanide discharge limit in the facility's NPDES Permit for Outfall 004 is a daily average of 2.5 mg/L and monthly maximum of 5 mg/L. Cyanide discharges from Outfall 004 have been decreasing over the years and have been below this discharge limit.

Areas of Former Potliner Management and their stormwater drainage at the facility include the following:

- Old Northwest Pot Dump;
- Pot Soaking Piers;
- Potliner Loadout Area;

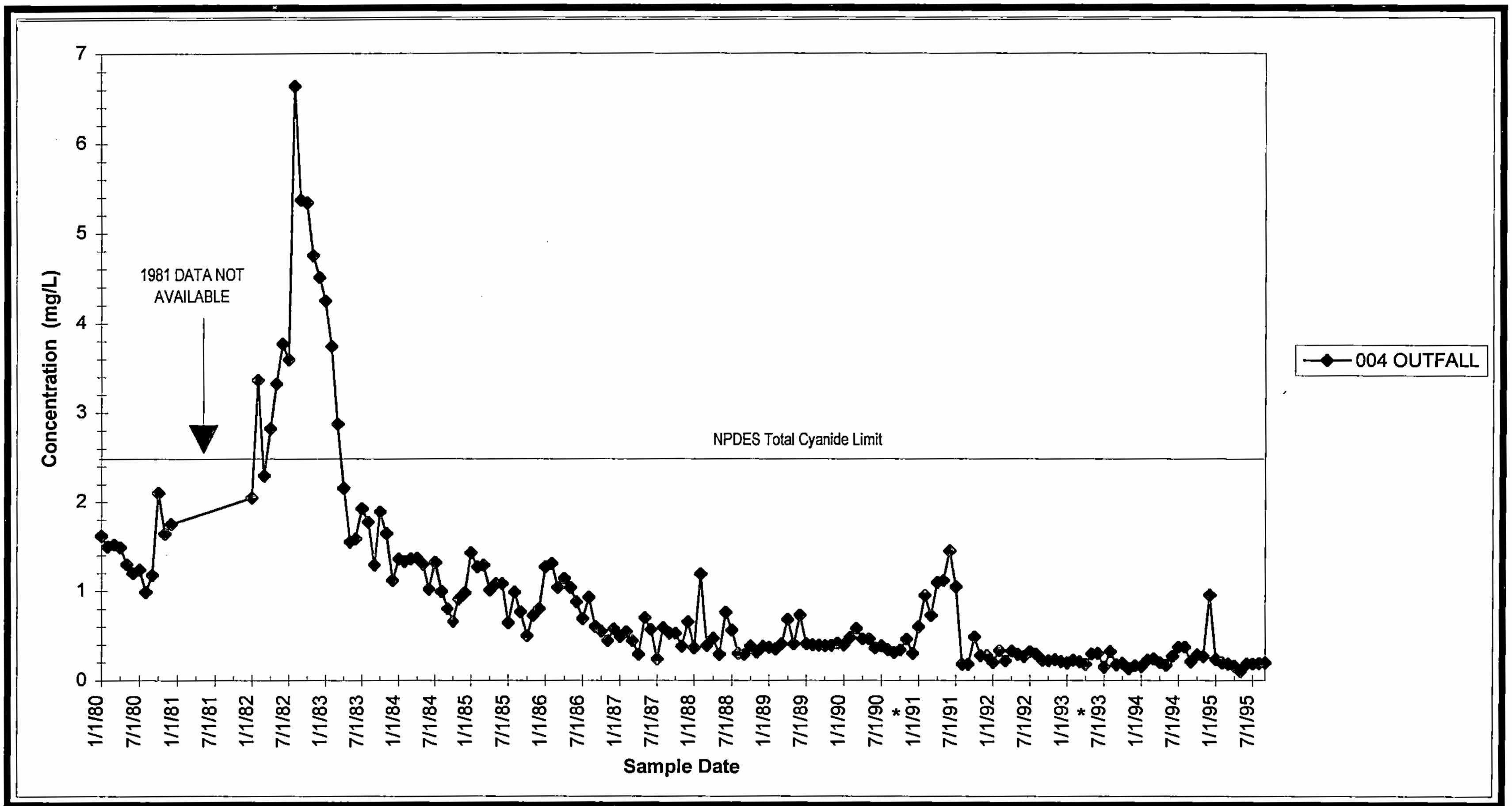
- Pot Soaking Pits and Elephant Shed;
- Potliner Pile;
- Potliner Vault;
- Potliner Breakout and Accumulation Buildings (Buildings 65 and 66).
- The Drainage Path receiving stormwater runoff from the Elephant Shed and the Potliner Pile and the former locations of the Pot Soaking Pits and Pot Soaking Piers;
- The Northwest Pot Dump Drainage Path conveying stormwater runoff from the Old Northwest Pot Dump to the Bottomlands; and
- Outfall 003.

It is recommended that soil samples be collected from the areas in or around the Old Northwest Pot Dump, Northwest Pot Dump Drainage Path, Bottomlands, Potliner Loadout Area, Potliner Breakout and Accumulation Buildings, Pot Soaking Pits, Pot Soaking Piers, Potliner Pile, and Drainage Path. Soil and sediment samples should also be collected next to the Potliner Loadout Area and Outfall 003.

TABLE 4-1
CONCENTRATIONS OF CYANIDE IN SOILS (1)

AREA	NUMBER OF SAMPLE LOCATIONS	SAMPLE DEPTH (ft)	CONCENTRATION OF TOTAL CYANIDE (mg/kg)		
			RANGE	ARITHMETIC MEAN (2)	STANDARD DEVIATION
Waste Storage Pile (Potliner Pile)	11	0	0.61 - 47	4.5	7.1
		1.5	0.34 - 140	22	45
		5	0.053 - 330	65	114
		10	0.098 - 1,600	290	530
		15	0.21 - 220	54	71
		20	0.056 - 320	51	94
		25	0.084 - 320	59	120
		30	0.091 - 220	57	85
Bottomlands East of Rt.5	5	0	31 - 520	300	210
		1.5	220 - 1,300	650	470
		5	0.59 - 130	37	55
		10	<0.020 - 0.40	0.13	0.16
		15	0.051 - 0.35	0.11	0.13
		20	0.024 - 1.1	0.27	0.47
Old Northwest Pot Dump	5	0	0.43 - 1.8	0.81	0.56
		1.5	0.17 - 6.3	3.3	2.9
		5	<0.020 - 150	43	62
		10	<0.020 - 930	260	410
		15	9.9 - 1,300	320	550
		20	0.075 - 57	14	25
		25	0.025 - 600	150	300
Old Pot lining Loadout	3	0	19 - 1,100	390	620
		1.5	(3)	2.4	(3)
		5	1.3 - 8.9	4.5	3.9
		10	0.20 - 0.072	1.5	1.8
		15	0.052 - 0.072	0.060	0.010
		20	0.065 - 0.49	0.23	.23
		25	0.048 - 0.44	0.19	0.22
Pot Repair Buildings (Buildings 65 and 66)	3	0	0.12 - 1.9	1.5	1.2
		1.5	<0.020 - 0.2	0.094	0.10
		5	<0.020 - 0.035	0.011	0.020
		10	<0.020 - 0.023	<0.020	0.013
Anode Burnoff Pile	2	0	0.12 - 0.88	0.5	0.54
		1.5	0.13 - 0.58	0.36	0.32
		5	0.055 - 0.056	0.056	<0.001
		10	0.037 - 0.22	0.13	0.13
		15	0.048 - 0.47	0.26	0.30
Site of (Former) Surface Impoundment West of Pile	5	0	2.5 - 18	8.8	6.6
		1.5	7.4 - 40	21	14
		5	0.38 - 14	6.1	6.4
		10	0.099 - 8.9	5.2	3.8
		15	0.12 - 590	150	290

(1) Data from Comprehensive Hydrologic Investigation, Dames & Moore, 1982. Total cyanide analytical method described in Section 4.4.1
(2) Arithmetic mean calculated assuming zero cyanide concentration for results below detection limit.
(3) Only one sample was collected from this location



Different analytical lab was used from 11/90 to 4/92

Total Cyanide by Method 335.3

Figure 4-1
Average Total Cyanide at Outfall 004

RMT INC

g:\data\hydro\70410\graphs\004OFcn2.xls

70410.24
Ravenswood Aluminum Corporation
Ravenswood, VA

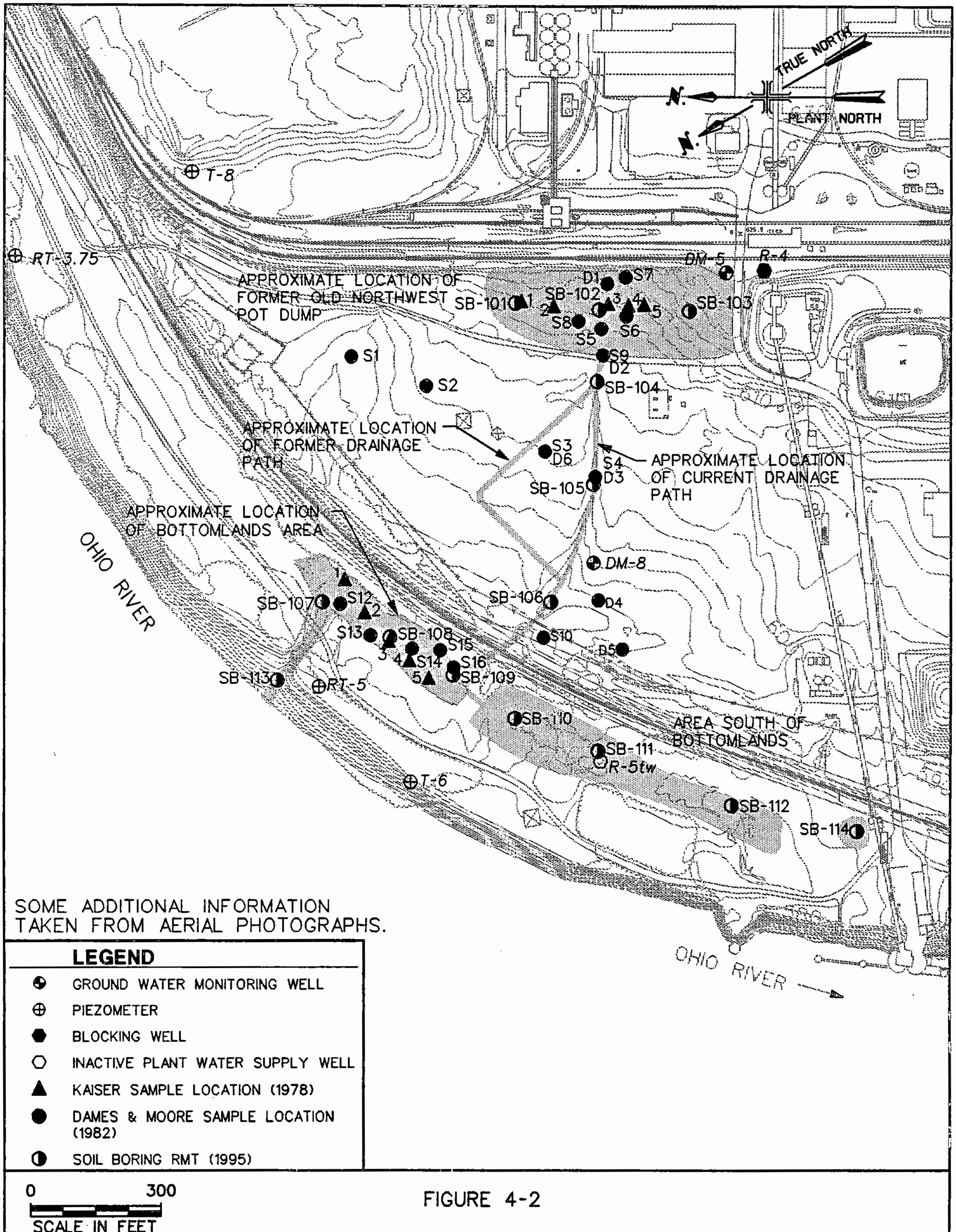


FIGURE 4-2

SOIL SAMPLING LOCATIONS AT OLD NORTHWEST POT DUMP AND BOTTOMLANDS

RMT 70410.07 0396

RAVENSWOOD ALUMINUM CORPORATION
RAVENSWOOD, WV

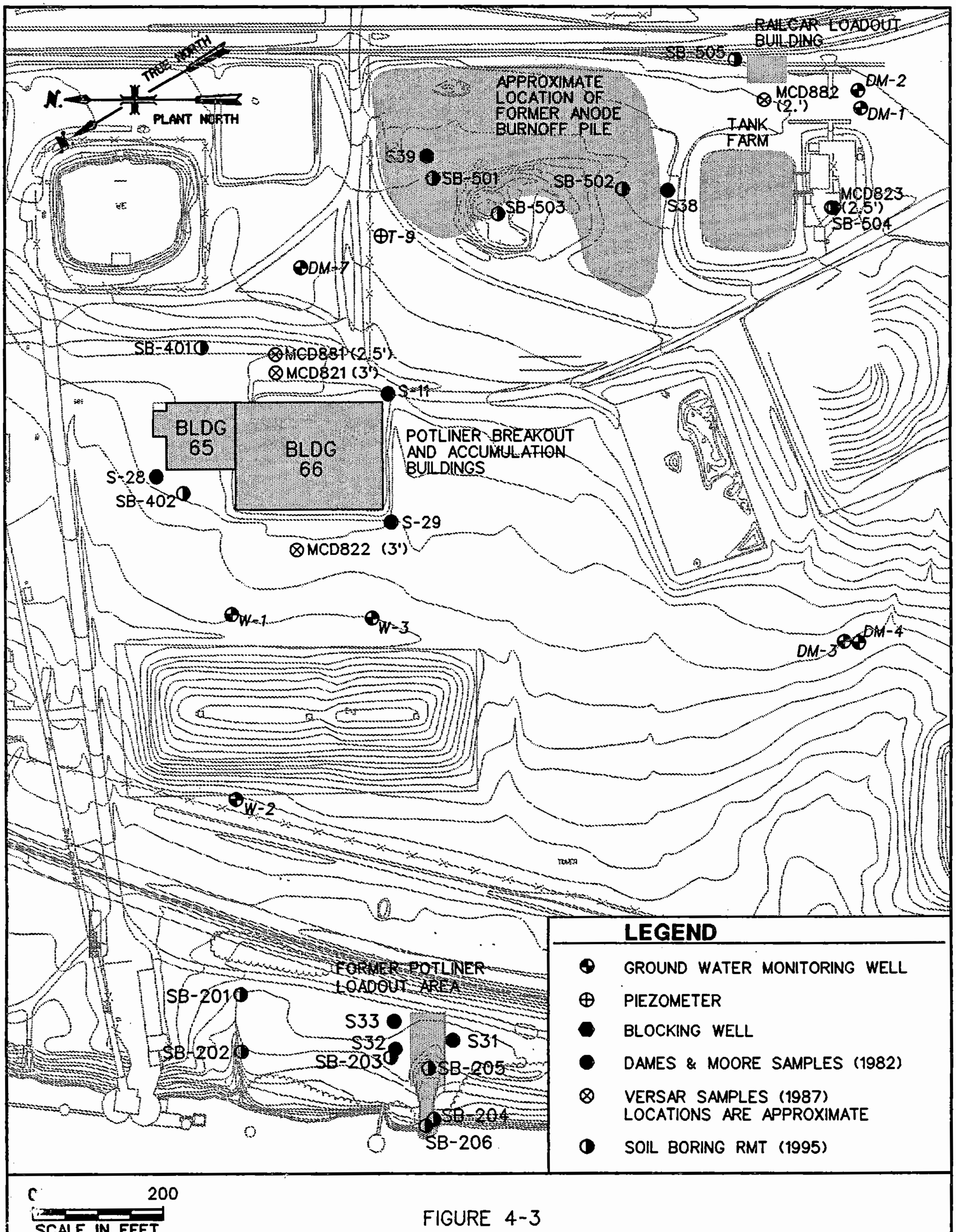
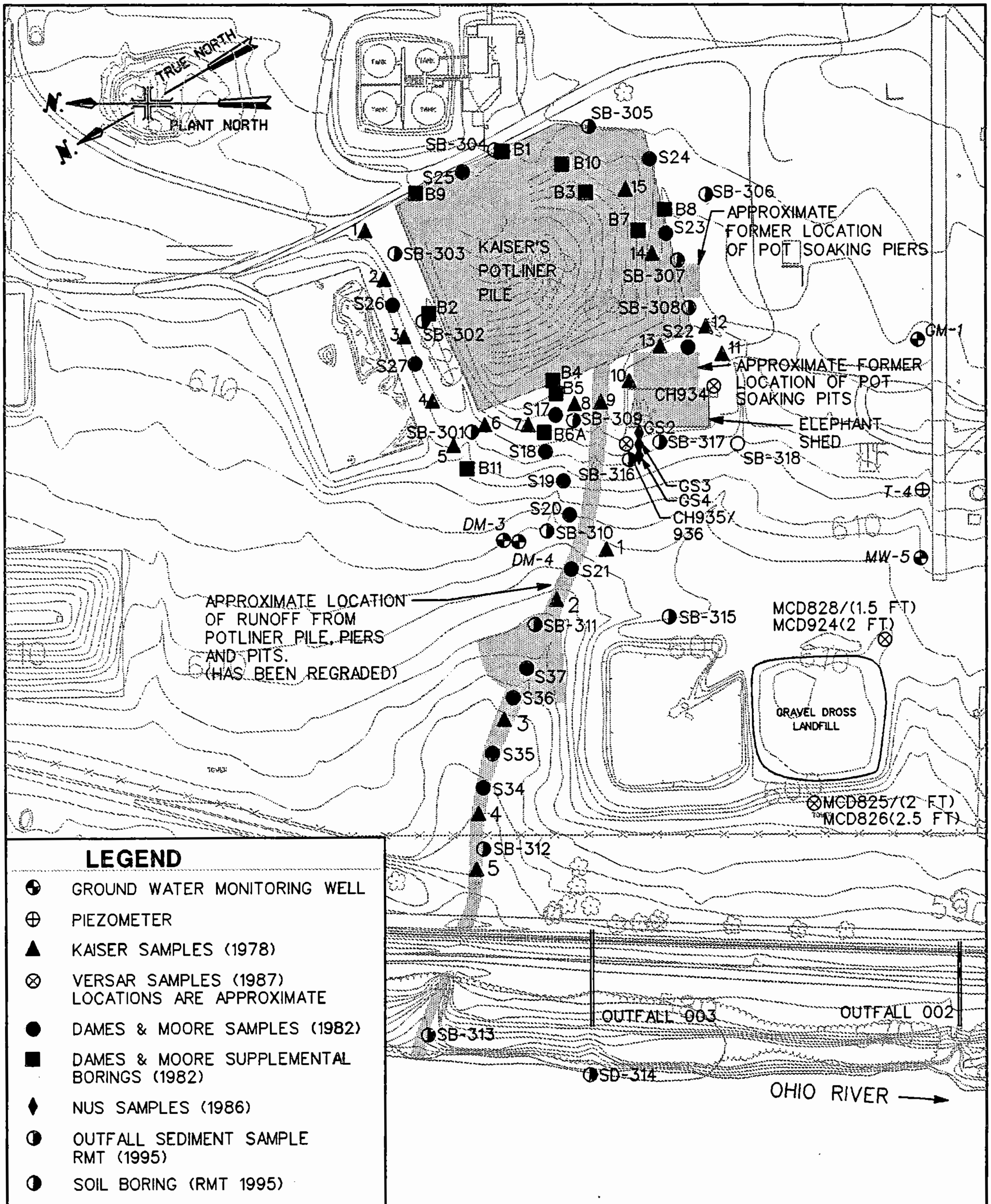


FIGURE 4-3

SOIL SAMPLING LOCATIONS AT POTLINER MANAGEMENT AREAS

RMT 70410.01 0995

RAVENSWOOD ALUMINUM CORPORATION
RAVENSWOOD, WV



0 200

SCALE IN FEET

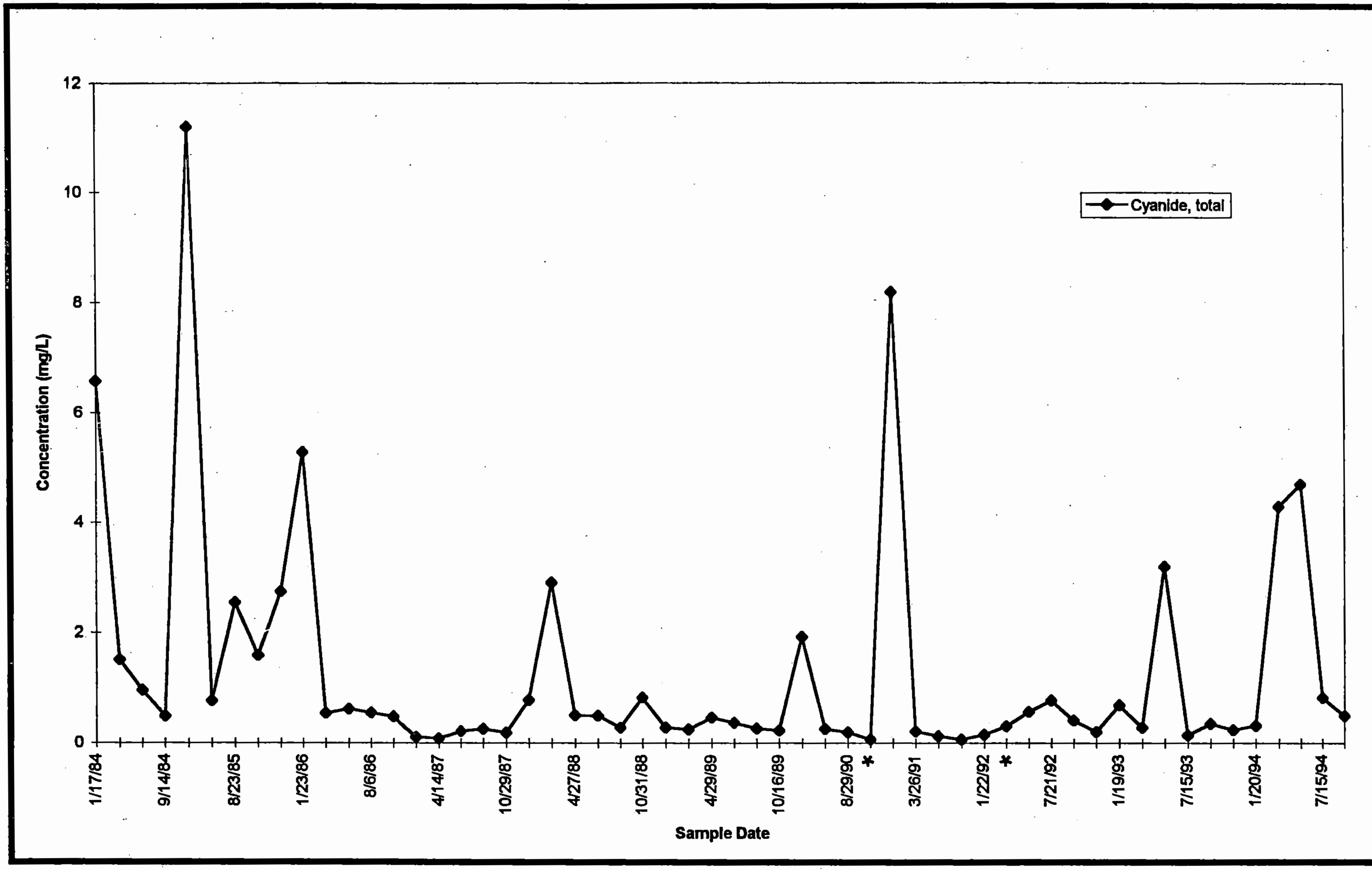
FIGURE 4-4

SOIL SAMPLING LOCATIONS AT POTLINER PILE AND ELEPHANT SHED

RMT

70410.07
0396

RAVENSWOOD ALUMINUM CORPORATION
RAVENSWOOD, WV



* Different analytical lab was used from 11/90 to 4/92

Figure 4-5
Total Cyanide in Monitoring Well DM-8

RMT INC
g:\data\hydro\70410\graphs\dcc.xls

70410.21
Ravenswood Aluminum Corporation
Ravenswood, WV

5.0 POTLINER PILE

The Spent Cathode Pile was listed by NUS (US EPA Contractor) in the 1986 Interim RFA Report and by Versar (US EPA Contractor) in the 1988 RFA Report as SWMU 1. This unit is called the Potliner Pile in this DCC Report. The Potliner Pile is owned and maintained by KACC. Consequently, it is beyond the scope of the RFI activities to be conducted by RAC. However, sampling to assess possible soil impacts or impacts from surface water runoff from the Potliner Pile onto RAC's property is described in the Data Collection Quality Assurance Plan in the RFI Workplan.

6.0 POTLINER BREAKOUT AND ACCUMULATION BUILDINGS

6.1 GENERAL DESCRIPTION OF POTLINER BREAKOUT AND ACCUMULATION BUILDINGS

In 1979, the Potliner Breakout and Accumulation Buildings were constructed to facilitate potliner removal and management in an enclosed environment (Dames & Moore, *Comprehensive*). These units replaced the Elephant Shed as the location for potliner breakout and accumulation operations. In the 1986 NUS (US EPA Contractor) Interim RFA and in the 1988 Versar (US EPA Contractor) RFA Report, the Pot Repair Potlining Storage Buildings were listed as SWMU 2. These areas are now called the Potliner Breakout Building (Building 65) and the Potliner Accumulation Building (Building 66).

6.1.1 Location

The Potliner Breakout and Accumulation Buildings are located to the north and west of the Potliner Pile, as shown in Plate 2.

6.1.2 Construction and Modifications

The Potliner Breakout and Accumulation Buildings, which are pre-engineered buildings set on concrete foundations and finished with aluminum siding, were constructed in 1979. Building 65, the Potliner Breakout Building, measures approximately 100 feet by 100 feet. This building contains a 60-ton crane. The Potliner Accumulation Building, Building 66, measured 100 feet by 160 feet when it was constructed. Original drawings of these structures are contained in Appendix E-1.

In 1984, Building 66 was expanded to the south by 125 feet, resulting in a building measuring 225 feet by 160 feet. The original interior guard wall was removed and replaced with a pre-cast concrete guard wall and earth berm. Drawings for these modifications are contained in Appendix E-1. In 1991, an enclosed truck loading ramp was constructed in Building 66. Drawings for this addition are shown in Appendix E-1.

6.1.3 Operation and Management

6.1.3.1 Past Operations

After construction of the Potliner Breakout and Accumulation Buildings in 1979, potliner breakout and accumulation activities were moved from the Elephant Shed area to these new buildings. Pots requiring reconstruction were moved from the Reduction Plant to Building 65. In Building 65, the pot pads (solidified nonsiphoned aluminum which was present in the pot at the time of pot failure) with some attached solidified bath, were removed from the pots. Then, the remaining potliner was broken inside this steel pot shell through the use of a hydraulic ram and other tools. The steel collector bars were removed for recycling after the contents of the pot were dumped on the floor. The aluminum pot pads, with some attached bath material, were moved on to a paved area outside the Potliner Breakout and Accumulation Buildings while awaiting transportation to a recycler. After removal from the pot shell and separation from the collector bars, the spent potliner was moved into Building 66 and placed on the floor of this building.

Originally, the potliner was accumulated in Building 66. However, within 1 year of the construction of the Potliner Breakout and Accumulation Buildings, Building 66 had been filled with spent potliner. At this time, KACC applied for and received a one-time permit to place this spent potliner material in the Potliner Pile. Spent potliner material was relocated to the Potliner Pile. This part of the pile has a soil/bentonite bottom and cover and has been referred to previously in the document as the subsidiary pile to the Potliner Pile. After this, the generation of potliner decreased because of advances in industry technology and use of microprocessors on each pot to monitor pot conditions and supply process control. From 1980 until the sale of the plant in 1989, KACC accumulated spent potliner materials in Building 66 while awaiting relocation to the Potliner Vault. The Potliner Vault was constructed to ensure secure containment of the spent potliner material. Prior to the 1989 sale of the facility, all spent potliner accumulated in Building 66 was moved to the Potliner Vault, and the vault was closed as a landfill. The Potliner Vault continues to be owned and maintained by KACC. Prior to 1992, the potliner was accumulated on the floor of Building 66.

6.1.3.2 Current Status

The pot break out procedure described in Section 6.1.3.1 continued until May 1992, when spent potliner was relisted as a hazardous waste. Since 1992, the potliner has been accumulated in Building 66 in steel tubs which hold about 6.5 tons each. These tubs are covered, labeled, dated, and moved into an accumulation area in Building 66. The tubs of spent potliner are accumulated for less than 90 days in Building 66. The tubs are emptied into dump-trailer trucks or railcar and then transported in bulk to a RCRA permitted hazardous waste landfill or treatment facility. A truck unloading ramp was constructed inside Building 66 in 1991 to facilitate loading of trucks in an enclosed environment. A wall of dust shrouds consisting of heavy gauge plastic strips arranged with 50 percent overlap was placed across the truck loading ramp to minimize airborne migration of the dust generated during loading and unloading of spent potliner materials in this area. The dust is swept up periodically and placed in the covered bins containing spent potliner material.

6.1.4 Possible Hazardous Constituents

The only possible hazardous constituent associated with the Potliner Breakout and Accumulation Buildings is cyanide, which is formed at high temperatures over time in the carbon cathode portion of the potliner.

6.1.5 Possible Migration Pathways

Cyanide will not be released from these potliner materials unless they are contacted with water. Since the potliner has been stored inside at this location since its construction, the possibility of contact with water is minimal.

The only possible release of potliner material from Buildings 65 and 66 to the environment would be through dispersion of any dust that is generated from activities occurring within the buildings. Dust is generated during potliner breakout and loading on trucks. The majority of this dust is alumina ore and cyrolite bath present in the pots when they fail. During the 1994 Malcolm Pirnie site visit, dust-like material was observed outside the northwest corner of the building near the ventilation exhausts.

6.2 INVESTIGATIONS OF SURROUNDING SOILS

The 1982 Dames & Moore hydrogeologic investigation report noted low concentrations of cyanide in soil samples in the vicinity of this building (see Section 4.0 for details). Sampling locations are shown in Figure 4-3. Dames & Moore concluded their report with specific recommendations for the Potliner Breakout and Accumulation Buildings and general recommendations pertaining to the handling of potliner at the facility. These recommendations are presented below along with KACC's and RAC's corresponding actions or responses:

- Dames & Moore recommended that minor improvement be made to the Potliner Breakout and Accumulation Buildings, including repairs to the building siding, improvement in fugitive dust control, and measures to prevent spillage of potliner materials. In 1984, the repairs to the siding were performed, and KACC established practices to minimize fugitive dust emissions and prevent spillage.

- Dames & Moore recommended that all transfers of spent potliner material be completed under dry conditions and that all pots awaiting separation be protected from the weather. KACC performed these operations from 1983 until the property was sold in 1989. RAC has performed these operations as recommended since 1989.
- Dames & Moore recommended that future accumulation facilities be designed and operated to prevent contact between potliner material and water from any source. The expansion of the Potliner Accumulation Building in 1984 incorporated this recommendation.

In the 1986 Interim RFA Report, NUS stated that there was no evidence of a significant release or of poor waste management practices present at this unit. NUS concluded that the "extremely low levels of cyanide detected in the soil were not considered to require further assessment," so no further action was recommended.

During the 1987 RFA Sampling Visit, two soil samples were collected by Versar in the vicinity of the Potliner Breakout and Accumulation Buildings (Versar, *RCRA*). No cyanide levels above detection limits were reported in either of the two soil samples analyzed (see Appendix D-1 for analytical results). In the Draft RFA, Versar stated that no evidence of chemical release was identified around the Potliner Breakout and Accumulation Buildings and that no further regulatory action was necessary.

6.3 ASSESSMENT OF FURTHER INVESTIGATION NEEDS

In order to confirm the nominal soil cyanide concentrations reported in the 1988 Versar RFA Report, soil sampling will be performed at locations outside the Potliner Breakout and Accumulation Buildings where any dust from the buildings would likely settle. The details of the proposed soil sampling are contained in the Data Collection Quality Assurance Plan of the RFI Workplan.

6.4 SUMMARY OF POTLINER BREAKOUT AND ACCUMULATION BUILDINGS

In 1979, the Potliner Breakout and Accumulation Buildings, Buildings 65 and 66, were constructed to facilitate potliner removal and management in an enclosed environment. These buildings are located to the north and west of the Potliner Pile. These units are pre-engineered buildings set on concrete foundations and finished with aluminum siding.

In Building 65, the pot contents are broken out from the steel pots. After removal from the pot, the spent potliner material is moved into Building 66 and accumulated there for less and 90 days while awaiting transportation to a RCRA permitted hazardous waste treatment or disposal facility. Soil sampling is proposed at locations outside of the building where any fugitive dust generated during potliner breakout activities may settle.

7.0 ROTARY BARREL BAGHOUSE CATCH LANDFILL

The Baghouse Landfill was listed in the 1986 Interim RFA Report by NUS (US EPA Contractor) and the 1988 RFA report by Versar (US EPA Contractor) as SWMU 3. This landfill was actually more properly termed the Rotary Barrel Baghouse Catch Landfill. KACC had designed the unit and applied for a permit for the unit in 1980; however, the Rotary Barrel Catch Landfill was never constructed. Baghouse dust was placed in the Industrial Landfill until it was closed in November 1992. Currently, miscellaneous waste dusts are disposed of off site as a solid waste. There is no further need to include the nonexistent Rotary Barrel Baghouse Catch Landfill in the RFI process.

8.0 TANK 1 AND EMERGENCY SPILL BASIN

8.1 GENERAL DESCRIPTION OF TANK 1 AND EMERGENCY SPILL BASIN

Tank 1 and its associated Emergency Spill Basin were listed in the 1986 NUS (US EPA Contractor) Interim RFA Report and the 1988 Versar (US EPA Contractor) RFA Report as SWMU 4. Tank 1 receives waste coolant from the hotline rolling mill operations. High water content oils and oily wastewaters enter the Oil Recovery System through the sump at Tank 1. The generation and management of waste coolant is described in Section 2.5.4. Other materials that enter the system through the Tank 1 sump are discussed in Section 2.5.4 and Section 2.5.6. Use of the Tank 1 area is also discussed in greater detail in Section 8.1.3.1.

8.1.1 Location

Tank 1 and the Emergency Spill Basin are located just west of the Fabrication Plant as shown in Plate 2 and Figure 2-2.

8.1.2 Construction and Modifications

Tank 1 was constructed sometime prior to 1971 and has a capacity of 600,000 gallons. The tank has a diameter of 62 feet and a height of 27 feet. In 1971, Tank 1 was moved from its original location, which is shown in Figure 8-1. The area previously occupied by Tank 1 is adjacent to the Fabrication Plant just north of the Oil Reclamation Building. A concrete pad and sump were constructed at this same time, and these units are located just south of Tank 1. In 1971, a 600,000-gallon Emergency Spill Basin was constructed next to Tank 1, and a concrete containment curb and earthen berm were placed around Tank 1. The Emergency Spill Basin is lined with a 50 mil hypalon liner. The hypalon liner is routinely inspected and it is repaired as necessary. The most recent repairs occurred in 1993. Drawings of Tank 1 and the Emergency Spill Basin are contained in Appendix F-1.

8.1.3 Operation and Management

8.1.3.1 Past Operations

A description of the operation of the Oil Recovery System is provided in Section 9.0, including a discussion of the Oil Recovery System interim status closure operations which included a cleanout of residuals from Tank 1 and the Emergency Spill Basin.

The pad located south of Tank 1 is used for a variety of activities that result in the generation of oily wastewater. The oily water drains to the 10,000-gallon sump located at Tank 1 and is subsequently pumped into a gravity feed pipe to the Oil Recovery Ponds for separation of the oil and treatment of the water. Solids remaining on the pad after the liquids drain to the sump are placed in bins for disposal as solid waste or recycling. Activities conducted on the Tank 1 pad include washing oil off equipment from the mill that requires servicing and washing out vacuum trucks that are used to remove nonhazardous dust, oily materials, and liquids from sumps and ditches. Other materials handled on the Tank 1 pad include spent paper filters from coolant reclamation, diatomaceous earth from cold mill coolant filtering, and lubricating oils from the Fabrication and Reduction Plants. Metal cuttings from maintenance activities performed in the Reduction Plant garage, Fabrication Plant machine shop, and Fabrication Plant roll shop, as well as fine saw cuttings from Fabrication, are also drained of free oil within the concrete containment area at the Tank 1 sump and subsequently placed in bins for solid waste disposal or recycling, as appropriate. Sediments are periodically removed from the sump and sent off site for stabilization and disposal in a solid waste landfill.

The Tank 1 containment area and Emergency Spill Basin were designed to contain any releases from Tank 1. Discharges from Tank 1 were to be partially contained by the curb and earthen berm surrounding Tank 1 with the excess volume to be transferred to the Emergency Spill Basin. Material from the Emergency Spill Basin could then flow by gravity to the Oil Recovery Ponds or be pumped back into Tank 1 after the cause of the release had been corrected. Three releases from Tank 1 have occurred, one each in 1978, 1982, and 1989. These releases were described in Section 2.7 of this DCC Report. In all cases, the released coolant flowed through a small gap between the earthen berm and the curb into the ditch along the adjacent road. Vacuum trucks were called on site to remove the released waste coolant after the 1982 and 1989 spills. The ditch is no longer present.

8.1.3.2 Current Status

The current operation of Tank 1 is described in relation to the entire Oil Recovery System in Section 9.0. Tank 1 is currently used as an equalization tank for the nonhazardous waste coolant before it is transferred to the Oil Recovery Ponds. Operation of the Tank 1 pad and sump has changed as follows. All waste oils are subject to an emulsion test. Those that are strong emulsifiers are shipped off site for disposal or recycling. The remaining oils are sent to either the Tank 1 sump or the Tank Farm sump, depending on water content.

8.1.4 Possible Hazardous Constituents

Prior to 1985, the waste coolant transferred to Tank 1 contained lead. The source of this lead was leaded gear lubricants. The use of leaded gear lubricants was discontinued in 1985, but releases of coolant containing lead did occur in 1978 and 1982. Clean-up activities associated with these releases are as detailed in Section 2.7. As discussed in Sections 2.5 and 8.1.3.1, a variety of oily wastes have been, and continue to be managed at Tank 1. These wastes include hotline coolant emulsion; gasoline from the perimeter containment sump at the facility gasoline pump island; hydraulic oils from carbon presses; used motor oils, lubrication oils, transmission fluids, and antifreeze from the vehicle maintenance garages; cutting oils and lubricants from the machine shops; hydraulic oils, gear oils, and other oil-based lubricants used during routine maintenance and major equipment overhauling in the Reduction and Fabrication Plants; cutting oils and other lubricants used to refurbish tools and equipment from the rolling mills and finishing departments in the Fabrication Plant; accumulated rainwater from oil drum storage area sumps; oil collected by the skimmer systems in the interceptor basins (Outfalls 001, 002, and 004); and oil skimmed from cooling towers for contact cooling water.

Most of the materials managed at Tank 1 are petroleum based hydrocarbons. The predominant constituents are expected to be alkanes. Used petroleum products typically also contain fine metal particulates, dirt, and some complex derivatives of the simple chain and ring molecules in virgin petroleum products. Ravenswood is sampling at locations of stained soil in the Tank 1 area during the RFI (see Figure 8-1). These samples will be analyzed for Appendix IX constituents.

8.1.5 Possible Migration Pathways

Tank 1 is a secure tank and is surrounded by a concrete containment wall and an earthen berm. The Emergency Spill Basin is bermed and lined with a hypalon lining. Therefore, there are no possible migration pathways associated with Tank 1 and the Emergency Spill Basin unless a major spill occurs. If a major spill occurs, the released constituents could percolate into the ground and leach into the groundwater. However, standard spill response and clean-up practices include containment and cleanup of spilled liquids and contaminated soils, eliminating the possible migration pathway. The past releases from Tank 1 noted in Section 8.1.3 were addressed when necessary, and subsequent sampling by Versar in 1987 did not indicate hazardous constituents at any significant concentrations (see Section 8.2).

8.2 INVESTIGATIONS OF SURROUNDING SOILS

During the 1987 Versar RFA Sampling Visit conducted between April 27 and May 1, 1987, Versar collected a single soil sample near the metal chip unloading station adjacent to Tank 1 and the Emergency Spill Basin because the surface soils were stained in this area. Figure 8-1 shows the approximate sampling location. The sample was analyzed for TCL volatiles, total metals, and oil and grease content. Chromium was detected in this sample at a concentration greater than that in the background sample, which was collected near production well F-9. Analysis of this sample also indicated the presence of methylene chloride, 1,1,1-trichloroethane, toluene, and oil and grease (see Appendices D-1, D-2, and D-3 for analytical results). It should be noted that methylene chloride is a common laboratory contaminant and was detected in laboratory blanks associated with this sampling event. In the Draft RFA, Versar concluded that impacts to the environment from this unit were localized and minimal and that no further enforcement corrective action at this unit was necessary.

8.3 ASSESSMENT OF FURTHER INVESTIGATION NEEDS

There have been only three known releases of waste coolant from the Tank 1 area, and two of these releases were followed up by clean-up activities. Currently, there is no evidence around Tank 1 of the releases or impacts from the releases around Tank 1. The concentrations of methylene chloride, 1,1,1-trichloroethane, and toluene detected in the soil samples collected from this area for the 1988 RFA Report were below US EPA Region III risk-based screening levels for both industrial and residential soils (US EPA Region III, *Selecting*). In their Draft RFA, Versar concluded that a release of oily material likely occurred in a localized area near Tank 1, and that release appeared to have had minimal effects on the soils. In this draft report, Versar concluded that no further corrective enforcement action was necessary.

Additional samples are proposed for the Tank 1 area as detailed in Section 3.8.11 of the approved RFI Workplan. One sample will be collected from the drainage ditch that has received releases from Tank 1 and one sample will be collected from a location between Tank 1 and the Emergency Spill Basin near the Versar sampling point.

The Emergency Spill Basin normally contains only incidental rainwater. The basin is used infrequently for short durations to hold waste coolant when weather conditions restrict the use of the Sprayfield. Although it first held waste coolant in 1987, after the use of leaded bearing greases was discontinued, the Emergency Spill Basin was decontaminated during the interim status closure of the Oil Recovery System. There is no visual or other information to suggest releases may have occurred from the Emergency Spill Basin. According to US EPA's RCRA Facility Investigation Guidance [EPA/530-510-89-031, May 1989], no further action is appropriate where there is no evidence of a release or suspected release. Therefore, no further action concerning the Emergency Spill Basin is proposed.

8.4 SUMMARY OF TANK 1 AND EMERGENCY SPILL BASIN

Tank 1 receives waste coolant from the hotline rolling mill operations. The waste coolant flows by gravity to the Oil Recovery Ponds. Tank 1 has a capacity of 600,000 gallons. A concrete pad and sump and a 600,000-gallon Emergency Spill Basin are located next to Tank 1. Three releases have occurred from Tank 1, one each in 1978, 1982, and 1989. In all cases, the released coolant flowed into a ditch along the road adjacent to Tank 1. Tank 1 and its associated piping and the Emergency Spill Basin had all residuals removed and were closed under interim status along with the rest of the Oil Recovery System in 1988. After the closure, only nonhazardous waste coolant was managed in Tank 1 and its associated piping and basin.

Possible hazardous constituents associated with Tank 1 operations prior to RAC's purchase of the facility include lead, and some organic compounds. Past and current possible hazardous constituents include any other hazardous constituents which may be among the various cycloalkanes and aromatic hydrocarbons associated with the 5 percent oil fraction of the waste coolant. Possible migration pathways for constituents in the event of a major release from Tank 1 or the Emergency Spill Basin could include percolation into the soil and leaching into the groundwater, but standard spill response and cleanup procedures limit this possible migration pathway.

Based on the known release of materials from Tank 1 to the adjacent ditch and observed oily soil, Ravenswood collected soil samples from two locations during the RFI as shown in Figure 8-1. These samples were analyzed for Appendix IX constituents.

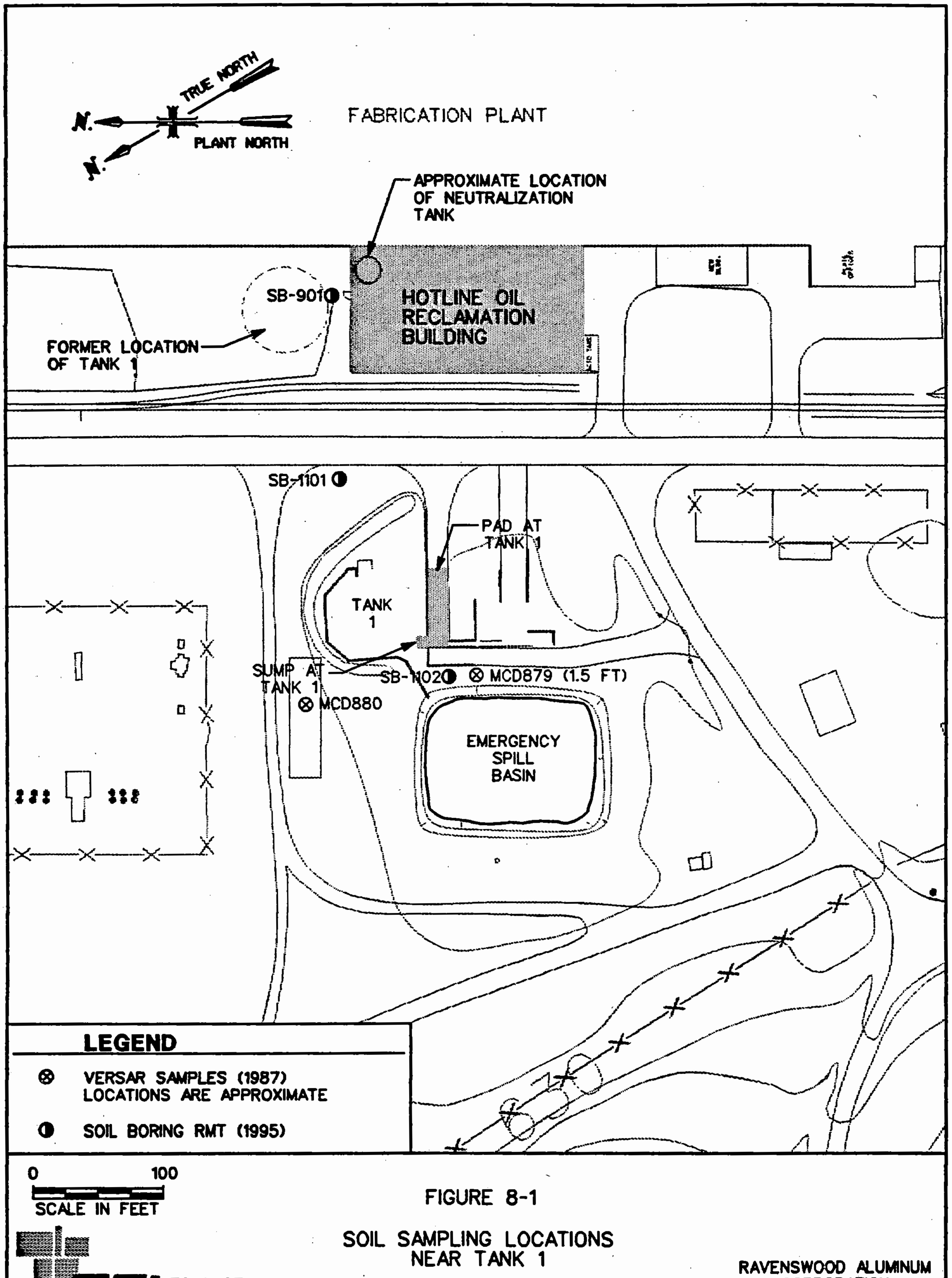


FIGURE 8-1

SOIL SAMPLING LOCATIONS
NEAR TANK 1

RAVENSWOOD ALUMINUM
CORPORATION
RAVENSWOOD, WV

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9.0 OIL RECOVERY PONDS

9.1 GENERAL DESCRIPTION OF OIL RECOVERY PONDS

Prior to mid 1985, KACC used a leaded gear lubricant on the hotline rolling mills. Leakage of this lubricant into the coolant caused the oil recovered from the waste coolant in the Oil Recovery System to contain lead concentrations in excess of 5 mg/L. Thus, the recovered oil was considered a D008 hazardous waste because it exhibited the hazardous characteristic of EP toxicity for lead. In 1985, KACC eliminated the use of leaded gear lubricant. Because of this operational change, KACC no longer generated a D008 hazardous waste (i.e., the recovered oil containing lead). During the 1986 Interim RFA, NUS (US EPA Contractor) listed the Surface Impoundments (hereafter referred to as the Oil Recovery Ponds) as SWMU 5. At that time and at the time of Versar's (US EPA Contractor) RFA Sampling Visit in 1987, there were three Oil Recovery Ponds that had been used to recover oil from waste coolant used on the hotline rolling mills.

In October 1985, KACC submitted a RCRA Closure Plan to US EPA and DNR for the Oil Recovery System listed in the 1980 Part A Application to US EPA and to DNR. This plan included the removal of the residual materials in the three Oil Recovery Ponds, elimination of residual sludges in any other storage units, and cleaning of the tanks, sumps, and piping equipment in the system. This plan was approved in September 1987, and closure activities began in May 1988. Since that time, the surface impoundments and associated storage tanks and equipment listed in the 1980 Part A Application have been closed according to DNR-approved interim status closure plan, and their closure has been certified by Roy F. Weston, Inc. Ponds 1 and 2 were reconstructed by KACC in 1988 and now recover nonhazardous oils from waste coolant. A Part B Post-Closure Permit Application was submitted by RAC to DNR in 1989. This permit application included corrective measures to remove the oil floating on the groundwater in the area of the Oil Recovery Ponds. In July 1991, DNR determined that the application was complete. An updated and revised Part B Application was submitted to DNR in July 1992 to incorporate additional information submitted to the agency during the review process. In September 1992, RAC submitted an addendum to the NPDES Permit Application requesting authorization for discharge of pumped groundwater associated with the corrective measures proposed in the Part B Permit Application. To date, the State has not taken action on this addendum.

9.1.1 Location

Ponds 1 and 2 are located west of the Fabrication Plant. The former Pond 3 was located south and west of Ponds 1 and 2. These locations are shown on Plate 2.

9.1.2 Construction and Modifications

Ponds 1 and 2 were originally smaller lagoons built in 1971. Pond 3 was constructed in 1972 to contain the recovered oil that had separated from the waste coolant placed in ponds 1 and 2. Ponds 1 and 2 were enlarged in 1977. Additional soil was excavated, and a bentonite liner was installed. Pond 3 was also relined with a soil/bentonite liner some time in the late 1970s.

As part of the interim status closure of the Oil Recovery System in 1988, Ponds 1, 2, and 3 were dredged and their contents solidified and removed (see Section 9.1.3.1 for details of closure). Ponds 1 and 2 were then equipped with a double synthetic liner and a leak detection system in 1988. Also in 1988, Pond 3 was backfilled and regraded to conform as closely as possible to the original site topography. No major modifications to the Oil Recovery Ponds have been made since the 1988 improvements. Current drawings for the ponds are contained in Appendix G-1.

9.1.3 Operation and Management

Since their construction, the ponds have been used to separate the recyclable oils from waste coolant, which is used in the sheet and plate operations at the facility. The coolant used on the rolling mills is approximately 5 percent mineral oil emulsified in demineralized water. Product specification information indicates that various cycloalkanes and aromatic hydrocarbon compounds are the major ingredients in the mineral-oil component of the hotline coolant. The mineral-oil component consists of 85 percent mineral oil; 12 percent fatty acids and soaps (as emulsifiers); and 3 percent glycol, alcohol, and biocides (Neal, *Land*). During aluminum rolling operations in the Fabrication Plant, emulsified oil coolant is sprayed on the rolling equipment. The emulsion is cooled by non-contact heat exchangers, filtered, chemically conditioned, and then recycled back to the rolls. When coolant can no longer be recycled, it is sent through the Oil Recovery System.

The current Oil Recovery System includes the following components:

- Tank 1, Tank 1 Sump, and Tank 1 Containment Basin;
- Ponds 1 and 2 (Pond 3 was closed under interim status and not rebuilt);

- Tank Farm pump house and storage tanks;
- Boiler House Day Tank; and
- All interconnecting piping and pumps used to transport recovered oil (all piping is underground).

9.1.3.1 Past Operations

From approximately 1957 to the late 1960s, the waste coolant from the hotline operations was phase-separated in Tank 1 and in a large redwood tank located on the second floor of the Oil Reclamation Building. The water phase was discharged to the Ohio River via Outfall 001. The oil phase was sold to an off-site processor. Because of limitations on the amount of oil in the discharge, KACC installed an emulsion break unit in the late 1960s. This emulsion break unit used heat and acid to increase the efficiency of the phase separation process. The operation of the Oil Recovery System at that time was as follows:

- Spent hotline emulsions and other oily wastes were transferred to Tank 1. In Tank 1, a partial separation of oil and water phases occurred. The water phase from Tank 1 was transferred to the large redwood tank in the Oil Reclamation Building, where acid and heat were used to break the emulsion.
- The oil phase from the emulsion break unit was returned to Tank 1. The oil in Tank 1 was transferred to the Boiler House Day Tank and used as specification fuel for the plant's industrial boiler or was sold to an off-site recycler.
- The water phase from the acid break system was discharged to the river via Outfall 001.

1969 to 1972 Operations

In 1969, the Corps of Engineers Permit for the facility limited the level of oil in discharges to the Ohio River to 10 mg/L (KACC, *Application Sprayfield*). At that point, various upgrades were made to the Oil Recovery System. In May 1971, Pond 1 was dug and the water phase from the emulsion break unit was diverted to this pond rather than being discharged to the Ohio River. The pond provided a significantly longer time period for natural phase separation to occur. The oil phase from the emulsion break unit and the pond was returned to Tank 1. The oil in Tank 1 was transferred to the Boiler House Day Tank and used as specification fuel for the plant's industrial boiler or was sold to an off-site recycler. In November 1971, Pond 2 was dug in order to obtain more operating capacity.

1972 to 1977 Operations

Discharge of the water phase of the separated emulsion was discontinued in 1972. In February 1972, a proposal for the limited testing of spray irrigation was submitted (KACC, *Application Springfield*). By November 1972, since the water phase of the emulsion was no longer being discharged to the river, approximately 1,600,000 gallons were stored in Ponds 1 and 2. A 1-year permit to test a spray irrigation treatment and disposal method was granted by the State of West Virginia in mid November 1972. The operation of the Oil Recovery System was as follows:

- Spent hotline emulsions and other oily wastes were transferred to Tank 1. In Tank 1, a partial separation of oil and water phases occurred while awaiting treatment by the acid break system. The emulsion then entered the acid break system. The oil phase from the acid break system was returned to Tank 1. The oil in Tank 1 was transferred to the Boiler House Day Tank and used as specification fuel for the plant's industrial boiler or was sold to an off-site recycler. The water phase from the acid break system was gravity fed to either Pond 1 or 2.
- The water phase remained in the oil ponds for approximately 3 weeks. During that time, physical oil/water separation occurred. The oil phase from the ponds was returned to Tank 1 and transferred to the Boiler House Day Tank.
- The water phase from the ponds, which contained less than 1 percent oil was then pumped onto the Sprayfield via three large, mobile sprinkler stations. These stations operated for 1 to 3 hours per day, three days per week. The stations were moved on a regular basis to new locations to avoid saturating any portion of the field.

In late December 1972, Dr. Paul Moe of West Virginia University (WVU) proposed a 3-year research project under his direction to study the effects of the long-term usage of spray irrigation as an ultimate treatment and disposal method for the water phase of the waste coolant. Pond 3 was constructed in 1972 to contain the recovered oil that had separated from the waste coolant placed in Ponds 1 and 2. The emulsion break process was discontinued in the mid 1970s, and the Tank Farm was installed in 1973. These changes resulted in the following operation of the Oil Recovery System:

- Spent hotline emulsion and other oily wastes were pumped into Tank 1 for intermediate storage.
- Upon filling Tank 1, the oily wastes were pumped to either Pond 1 or 2. The residence time in Ponds 1 and 2 was approximately 2 to 3 weeks.
- The oil phase on top of Ponds 1 and 2 was skimmed and transferred to Pond 3.
- The remaining emulsion phase was pumped to the Sprayfield through an aboveground aluminum irrigation grade pipeline. Upon reaching the Sprayfield, the water phase of the